

*IN THIS ISSUE:*

SHALL THE CORN FIELDS RUN OUR CARS?  
NEW CONCEPTS OF THE PAST CENTURY

# SCIENTIFIC AMERICAN

*A Weekly Review of Progress in  
INDUSTRY · SCIENCE · INVENTION · MECHANICS*



INSPECTING 140 SEPARATE POINTS OF AN AUTOMOBILE ENGINE CAM SHAFT—[See page 278]

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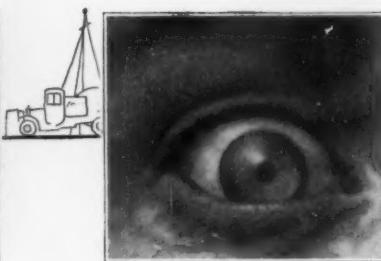
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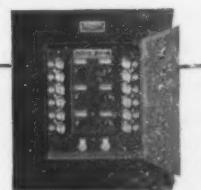
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SEVENTY-SIXTH YEAR

# SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CXXIII.]  
NUMBER 12

NEW YORK, SEPTEMBER 18, 1920

15 CENTS A COPY  
20 CENTS IN CANADA**A Mammoth Steam Unit and Its Work**

By Sydney G. Koon, M. M. E.

RECENT reports of a remarkable run made by a forty-five-thousand-kilowatt steam turbine in a Providence, Rhode Island, lighting plant have shown figures believed to be a world record for continuous service for a unit of this size. The run covered 84 days, 11 hours, 36 minutes, or a total of 2027.6 hours. During this period the machine turned out 50,791,000 kilowatt-hours, or an average of 25,050 kilowatts over the entire period. This was just 55.7 per cent of its rating.

Attention has been drawn to the great economy of this turbine, the result having been obtained from about 1.4 pounds of coal per kilowatt hour. It is believed that the average coal consumption in central stations of the United States, per unit of power delivered, is fully double this figure. Consequently this machine is working gallantly in an effort to cut down the high cost of living.

Some of the results of this run, when compared with familiar items, make rather startling reading. The total coal burned during the run was about 71,000,000 pounds, or 35,500 net tons. At the usual bulk of 43 cubic feet per ton, this gives 1,526,500 cubic feet, or a pile of coal 305 feet long, 100 feet wide and averaging 50 feet high. To carry this coal, twenty trains of forty-five cars each would be required, each car carrying forty tons. To carry it by water would require five colliers, each of 7,100 tons cargo capacity. The United States Navy includes five coal-carrying vessels of about this unit capacity, which cost for construction an aggregate of \$4,694,297.

The total steam consumption of the turbine is said to have been 609 million pounds. This represents the evaporation of 9,760,000 cubic feet of water, assuming that there was no water lost. The steam used, if at 200 pounds pressure, would have a total volume of 1,303,000,000 cubic feet, which is the equivalent of 87 Woolworth buildings. At atmospheric pressure it would form a continuous cloud of the width and height of the Woolworth building and 41 miles long.

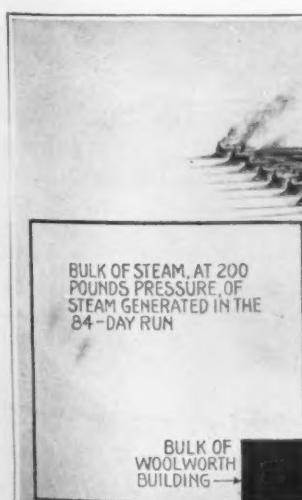
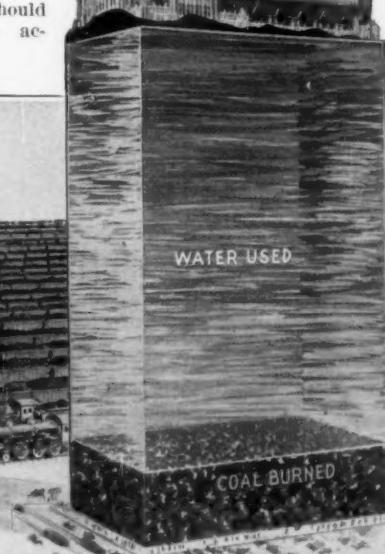
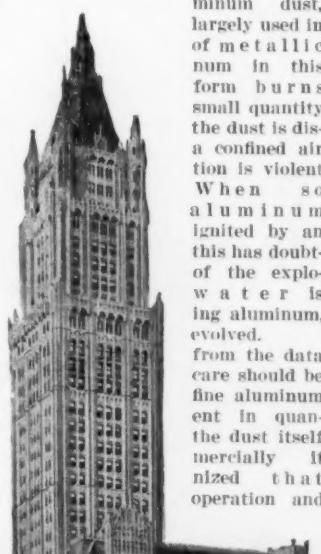
The amount of water which was evaporated into steam was sufficient to give every one of the 1,750,000 inhabitants of the world a drink of water, each

glass containing five and one-half ounces (one-third of a pint). This bulk of water would fill to an average depth of 6 feet 2 inches a swimming pool 30 feet wide and ten miles long, stretching from the Battery to two miles above Grant's Tomb, in New York City.

**Aluminum Dust Explosions**

WE have had ample opportunity to know that ordinary dusts when suspended in air are highly explosive and the effects of explosion of gun powder, gun cotton, and the like, are understood for they depend upon the production of large volumes of hot gas of high critical point. This familiar explanation does not hold in many other instances. The Bureau of Mines, for example, in Technical Paper No. 152, presents data with regard to an aluminum dust, largely used in the manufacture of paint. Aluminum is highly divided when a small quantity is ignited, but if tributed through space the combustion is violent. When so much aluminum is ignited by an electric spark and less caused some sions. When thrown on burning hydrogen gas is

It is evident presented that exercised where particles are present, and where is prepared commercially must be recognized. The safeguards to insure proper handling should be planned accordingly.



The coal burned would fill 50 feet of the Woolworth Building; the water used would fill the rest of the main structure to within a few feet of the tower's base. The coal would require twenty trains of forty-five cars each for its transport, and the steam generated, at working pressure, would fill 87 Woolworth Buildings, as indicated by the comparison of bulk at the lower left.

**Photographic Developers**

IT was to be expected that foreign manufacturers would endeavor to regale the American market and there have been numerous instances of advertising and other propaganda maintained for the purpose of retaining good will. In the January number of *Photographische Korrespondenz* of Vienna there is a note which refers to the progress made in America, although evidently the writer of the paragraph obtained his information from but one of our photographic periodicals since there are other manufacturers of these developers not mentioned. The article says that: "The cessation caused by the war of the exportation of photographic developers, of which Germany was the principal source of supply, caused foreigners to undertake the preparation of such substances in which attempts the German patent served as the starting point or was entirely used in the manufacture. The following developing substances similar to metol are found in the American market: monomet, serchol, phenomet, metol toch, rhodol (monomethyl para-mido-phenolsulfate), scalol, amidol, rexolon." Various claims of equality or superiority to the old German production which might be found in the advertisements of these materials are quoted in the article, which concludes with a reference to the desirability of the old German metol, notwithstanding the large number of competitors which the war has introduced.

**Water-Proofing**

IN a series of tests designed to improve the water-proofing of materials such as propellers for airplanes, the Forest Products Laboratory has demonstrated that when aluminum leaf can be used with a lacquer or varnish which cements it to the wood, the resulting coating is twenty-five times more effective than any other process for water-proofing wood. The leaf can be applied quickly and the cost is not prohibitive. The necessity for water-proofing a propeller is illustrated by the fact that at times eighty per cent of the propellers produced in France were rejected by the pilots, because of a lack of balance, much of which could be traced to unequal absorption of moisture. Of course, the same method of water-proofing is applicable to other appliances.



What the 84-day run of the big turbine means in terms of coal and water

# SCIENTIFIC AMERICAN

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*The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.*

*The editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.*

## The Einstein Judges

FTER a rather longer interval than we had anticipated, we are now able to announce the identity of the Einstein Judges. The decision as to the size of this committee we have made after careful consideration; and while we believe it to be a wise one, we realize that in some respects it may be a surprising one, and that the grounds on which it is based ought to be stated.

We are assured with complete certainty that the competition for the five-thousand-dollar-prize will be very keen, and that many essays will be submitted which, if they bore the names of their authors, would pass anywhere as authoritative statements. The judges will confront a task of extraordinary difficulty in the effort to determine which of these efforts is the best; and we believe the difficulties are such that multiplication of judges would merely multiply the obstacles to an agreement. It is altogether likely that the initial impressions of two or three or five judges would incline toward two or three or five essays, and that any final decision would be attainable only after much consultation and discussion. It seems to us that by making the committee as small as possible while still preserving the necessary feature that its decision represent a consensus, we shall simplify both the mental and the physical problem of coming to an agreement. We believe that the award should if possible represent a unanimous decision, without any minority report, and that such a requirement is far more likely to be met among two men than among three or five. At the same time, the bringing together of two men and the details of general administration of their work together are far simpler than if there were three or five. So we have finally decided to have but two judges, and in this we have the endorsement of all the competent opinion that we have consulted.

At the same time, a strict interpretation of the postal laws forbids that we introduce into the contest, by any suggestion of dividing the prize, what the Post Office looks upon as an "element of chance." It is therefore necessary to make provision against the remote contingency that the judges be really unable to reach an agreement. In this event, our own Einstein Prize Essay Editor will cast the deciding vote, between the two essays favored by the individual judges. Aside from this, of course, the SCIENTIFIC AMERICAN will have no voice in the award.

The gentlemen who have consented to act as judges are Professors Leigh Page and Edwin Plimpton Adams, of the departments of physics of Yale and Princeton Universities, respectively. Both are of the younger generation of physicists that has paid special attention to those phases of mathematics and physics involved in the Einstein theories, both have paid special attention to these theories themselves. We are gratified to be able to put forward as judges two men so eminently qualified to act. We feel that we may here appropriately quote Professor Page, who says in his acceptance: "As the large prize offers a great inducement, I had thought of entering the contest. However I realize that not many people in this country

have made a considerable study of Einstein's theory, and if all who have should enter the contest, it would be difficult to secure suitable judges." Without any desire to put the gentleman in the position of pleading for himself, we think this suggests very well the extent to which the SCIENTIFIC AMERICAN, the contestants, and the public at large, are indebted to Professors Page and Adams for their willingness to serve in the difficult capacity of judges.

## Aerial Stunts and Public Safety

IT was inevitable that, in his quest of the novel and sensational, the photographer would, sooner or later, enlist the services of the airplane; and it was probable that, in his effort to secure pictures of a sensational character, he would ultimately expose both the pilot and the public to very serious risks. Evidence of this was seen during the recent contests for the America's Cup off Sandy Hook, when the airplanes repeatedly flew at dangerously low altitudes over the fleet of yachts and excursion boats that were crowded around the starting line, some of them threading their way through the fleet at an elevation of only a few feet above the water.

It is well understood that if a skilful pilot is flying at considerable height, he can pull his machine out of a dangerous situation such as a side slip, a nose spin, or a tail spin; whereas, at a low altitude a crash is inevitable. The peril of taking aerial photographs of sporting events lies in the temptation to descend to low altitudes and slow down the flying speed—a dangerous combination should anything go wrong with the pilot or motor. As it was, there were several forced descents during the Cup races and it was more "by luck than good shooting" that no fatalities occurred.

It was reserved for the attempt to photograph the final match for the Tennis Championship at Forest Hills to demonstrate, in tragic fashion, the peril of close-up aerial photography. Two veteran airmen of the war, a pilot and a photographer, while circling outside the courts on which Tilden and Johnston were playing the final, suddenly went into a nose-spin and crashed a few hundred feet from the crowded grandstands. There is no doubt in the mind of the writer, who witnessed the fall, that these experienced men were the victims of their zeal to secure good close-up photographs—their maneuvers after they reached the grounds from Mitchel Field and the behavior of the machine at the turns and in the fatal plunge confirm this opinion.

When the machine first reached the vicinity of the courts it was at a height of apparently twelve to fifteen hundred feet. After circling the field, it came down to about nine hundred and finally to about five hundred feet. The pilot then throttled down to a speed that was slow even for a Curtiss JN-4. At this low elevation and slow speed the pilot closed in on the field, circling a few hundred feet outside of the court and grandstands. He never passed over the field at this elevation, the press statements to the contrary notwithstanding.

The flight of the machine when throttled down was noticeably unsteady, and the banking at the turns seemed to be excessive for the speed. Finally, off the northwest corner of the court, a sharp turn to the left was made, with an exceptionally high bank. The machine appeared to side slip, then dived steeply and immediately went into a nose-spin, and so low was the elevation that there was no possibility of recovery. Both men were killed.

The moral of this distressing accident, which has robbed the country of two experienced airmen, is that the taking of close-up aerial photographs of sporting events at which large crowds of people are assembled should be absolutely prohibited. Had the machine gone out of control a few hundred feet nearer the courts, it might well have fallen among the eight or ten thousand people on the stands, in which event a score or more of lives might have been lost and twice that number of people injured.

Furthermore these aerial pictures of sporting events are not worth the danger incurred. At the best they fail to show any illuminating detail of the play, and for practical purposes they are greatly inferior to the superb pictures which can be secured from the ground or from the top of neighboring structures.

The Army and Navy officials should put a ban upon photographic stunts of this kind and the State and Municipal authorities should follow suit.

## The Importance of Negative Results

ONE aspect of recent scientific developments which does not appear to have received its deserved attention, is the pointed lesson we have received regarding the importance of negative results in experimental investigations. It would be useless to deny the fact that the worker in science welcomes more heartily positive findings than the establishment of a negative conclusion. Science may be impersonal, abstract; but the scientific investigator is perforce concrete, human. He may set before him as an ideal an absolute impartiality, a complete freedom from bias, from desire to find anything but the truth, whether palatable or not. But ideals aside, he cannot help being in some degree influenced by a variety of factors, with the general result that he will on the whole give preference, in his selection of a task, to problems likely to lead to positive results.

It is therefore well that we should be reminded, from time to time, that negative results are always important, and, in certain instances, have proved of the very highest order of importance. Thus the foundation of the edifice reared by Einstein is the Michelson-Morley experiment, a classical piece of work conducted with consummate skill and care; the very fact that its results were negative necessitated the most extreme precautions, and none but expert experimenters would have been qualified to give us a report with the degree of reliability demanded in just such cases, where the effect looked for is either small or null.

It is interesting in this connection to note some of the other classical examples of negative results in experiments of superlative importance. There is, first of all, the accumulated evidence of numerous attempts to build a perpetual motion machine, resulting invariably in failure. It may be urged that these chimerical attempts were of necessity doomed to failure in view of the law of conservation of energy. But we may equally well say that the evidence of these consistent failures is one of the data on which we base our conviction in the law of conservation of energy. Similarly, the common experience that it is impossible to run an engine by the aid of the heat contained in a cold body (for example, to run an ocean liner by heat drawn from the sea) may be regarded as the basis of the so-called second law, the law which indicates the upper limit of efficiency attainable in a heat engine.

The mathematician too has a little group of negative results of his own that are of more than passing interest. For a great many centuries he tried to solve the classical problems of duplicating the cube, trisecting the angle, and squaring the circle; until his repeated failures led him to the conviction that the problems were not to be solved within the terms proposed. But he did not stop here; he has carried his investigations to the point where he can prove the impossibility of doing any of these things within the terms proposed, and can now say, not merely that failure to do them indicates their impossibility, but that they are impossible and he knows why. This categorical establishment of a negative result is something seldom met in other fields than the mathematical, and in fact enables the mathematician to escape much of the implicit sting of the failure to achieve something positive.

Some years ago we would have added to the list of classical negative results the attempts at transmuting elements. Today we have stricken out this item and placed it among the array of the accomplished facts of science, though to be sure the transmutation realized is not that active operation dreamed of by the alchemists, but a passive process over which we seem to have little or no control.

Lastly, of famous negative results, must be mentioned our failure to produce life by spontaneous generation. We are so accustomed, today, to the idea that life springs from life alone, that we hardly realize how to an earlier generation there seemed nothing in any way fanciful or improbable in the supposition that maggots, for example, originated directly and without intervention of parents, from decaying refuse.

## Engineering

**Canada's New Highways.**—Five million dollars will be spent this year in making better main highways of Canada through Federal and provincial grants. Of this amount the Dominion Government will contribute \$2,000,000 and the provincial governments \$3,000,000. This is the first year in which the road money has been available, and in view of the time taken in preparing plans the initial year's outlays will not be so heavy as in some succeeding years.

**Ashes as Road Material.**—The city of LaCrosse, Wisconsin, is to continue the plan adopted about two years ago of covering the city streets with ashes. By this plan the sandy and almost impassable streets are converted into smooth, hard driveways. In the last two years the Board of Public Works has thus improved about ten miles of streets, using the ashes from residences and factories. Between 30 and 35 loads of ashes (two yards per load) are required for the improvement of one block of sandy street, at a cost of a little over \$14 per block for haulage only, or about \$186 per mile, as against the old practice of paying to have them hauled and dumped on waste land.

**Pressure of Concrete on Forms.**—A pressure-gage devised by A. T. Goldbeck and used for the last few years in measuring earth pressures behind retaining walls and under fills, has been applied successfully to the measurement of the pressure of concrete on forms embedded therein. The gage consists essentially of an air-tight metal cell having a circular weighing face 10 sq. inches in area, according to the *Engineering News-Record*. The concrete pressure against the face of the cell is balanced by admitting compressed air to the inside of the cell. When the pressures are balanced an electrical contact is broken which extinguishes a light and signifies that the pressure shown on the gage connected with the air pipes is equal to the pressure of the concrete.

**Hydraulic-Fill Dams.**—The hydraulic method of dam construction has great advantages, but many dams built by it have failed. As often built the center of the dam is composed of a clay core completely water-tight but very wet as a result of the method of construction, and so completely water-tight that it is incapable of permitting its own drainage. This soft core exerts the pressure of a liquid of high specific gravity upon the toes, and tends to push them out. Most of the failures of this type appear to have been attributable to this pressure, continues Allen Hazen, in the *Proceedings of the American Society of Civil Engineers*. The commonly used method of placing the core results in an exceedingly fine-grained material, but though this is very desirable from the standpoint of a water-tight dam, it may be that the extreme tightness is secured at the expense of stability. For success in using the hydraulic method, it is necessary either to increase the dimensions of the toes until they are large and heavy enough to resist the full liquid pressure of the core, or else to handle the core material so that the finest particles are wasted, leaving only the largest ones, thereby increasing the grain size to a point where drainage can be secured, while remaining sufficiently impervious for practical purposes.

**Local Magnetic Disturbances** of intensity equalled nowhere else in the world were observed for some years by one Professor Leyst in the vicinity of Koursk, Russia. He attributed this to the presence of large undiscovered bodies of iron ore. His data have been rescued and transported to Sweden, where they have been worked over, with the result that it appears the deposits in question must be two in number, each 108 kilometers long, and the largest in the world.

## Astronomy

**Spectrum of Jupiter.**—Mr. V. M. Slipher reports that, with the aid of dyes for sensitizing dry plates for the lower spectrum, he has been able to extend the photographic spectra of the planets into lower wavelengths than were formerly accessible. He has presented to the American Astronomical Society the results of observations of the spectrum of Jupiter, which reveal several new bands and lines due to the selective absorption of the planet's atmosphere.

**Polariscope Observations During a Lunar Eclipse.**—M. P. Salet, of the Observatory of Paris, reports that the light of the moon during the total eclipse of May 3, 1920, was examined for polarization at that observatory, with Savart polariscopes placed before the eyepiece of a telescope. The different parts of the earth's shadow on the moon showed no trace of polarization. This result does not, therefore, support the observations

## CONDITIONS FOR THE \$5,000 PRIZE EINSTEIN ESSAY CONTEST

1. No essay shall be longer than 3,000 words.
2. All essays must be in English, and written as simply, lucidly and non-technically as possible.
3. Each essay must be typewritten, and identified with a pseudonym. The essay shall bear a title and the author's pseudonym only, and must be enclosed in a plain sealed envelope likewise bearing this pseudonym. In the same package with the essay must be sent a second plain sealed envelope, also labelled with the pseudonym, and containing a statement of the name and address of the contestant, the pseudonym used, and the title of the essay. It is necessary to follow these instructions implicitly, in order to guard against confusion in opening the envelopes and assigning the pseudonyms to their proprietors, especially in view of the possibility that two of the contestants may employ the same pseudonym. The envelopes should be sent in a single package to the Einstein Prize Essay Editor, SCIENTIFIC AMERICAN, 233 Broadway, New York.
4. All essays must be in the office of the SCIENTIFIC AMERICAN by November 1st, 1920.
5. The Editor of the SCIENTIFIC AMERICAN will retain the small sealed envelopes containing the competitors' names and addresses, which will not be opened until the competitive essays have been passed upon and the winning essay selected.
6. As soon as the judges have selected the winning essay, they will notify the Editor, who will open the envelope bearing the proper pseudonym and revealing the competitor's true name. The competitor will at once be notified that he has won, and his essay will be published in an early issue of the SCIENTIFIC AMERICAN.
7. There shall be but one prize, of FIVE THOUSAND DOLLARS, to go to the author of the best essay submitted.
8. The SCIENTIFIC AMERICAN reserves the right to publish in its columns, or in those of the SCIENTIFIC AMERICAN MONTHLY, or in book form, any of the essays which may be deemed worthy of this. Aside from such rights, the essays shall remain the properties of their authors; but no manuscripts can be returned.
9. The Committee of Judges will consist of Professors Leigh Page of Yale and E. P. Adams of Princeton. In the event that they are unable to agree on the best essay, the Einstein Prize Essay Editor will cast the deciding vote.

of Arago, during a lunar eclipse in 1844, and of Zantedeschii and Freeman during subsequent eclipses, all of these observers having reported that they found evidences of polarization in the light of the eclipsed moon.

**The First Astronomical Photographs in Colors** are said to have been those obtained by MM. Gimbel and Touchet of the total lunar eclipse of May 3, 1920, at the observatory of the Astronomical Society of France, in Paris. As this was a pioneer undertaking, no data were available as to the proper time of exposure. The camera was attached to the small equatorial of the observatory, and pictures were taken with exposures ranging from 3 to 40 minutes throughout totality. All proved to be under-exposed except that with the longest exposure, which showed different shades of red coloration and several details of the lunar surface. At the next lunar eclipse the photographers hope to use the great equatorial of the Meudon observatory, which should produce as satisfactory results with an exposure one-twenty-seventh as long. Supersensitized Lumière autochrome plates were used.

## Industrial Efficiency

**Fuel Oil for Railroads.**—The great scarcity of coal has caused the Paris, Lyons, and Mediterranean Railway Company to transform some of its motive power from coal to fuel oil consumption, which is about to be followed by the Chemin de Fer de l'Etat, or State-owned Railway, and engines at its shops at Saintes are now undergoing changes for experimental purposes. Much attention is being directed to the announcement that the first-named railway company is planning to equip 200 locomotives for fuel oil and install numerous storage reservoirs of from 40 to 100 tons' capacity at various points on its lines.

**Germany's Shortage of Gasoline.**—In a recent general meeting of the Society of German Motor Car Manufacturers complaint was made that sales are badly blocked by the shortage of gasoline; that the importation from the United States is, in spite of very

considerable orders most unsatisfactory seemingly on account of an enormous consumption in the United States; that it is hoped that Roumania will soon be able (as in former times) to again take up its gasoline export to Germany. In the course of the meeting it was further stated that it was planned to work hand in hand with the Austrian automobile industry concerning all economic questions.

**Pulpwood of Canada.**—Louis Piche, Provincial Forester, estimates that in Quebec there are 360,000,000 cords of all pulpwoods. Of this amount, there are 155,000,000 cords of available spruce and balsam which, at the present rate of cutting, namely, 3,000,000 cords per year, would give about 52 years' supply. It is estimated that there are, in Ontario, 250,000,000 cords of spruce and balsam. Of this it is estimated that at an early date the cut will be 1,500,000 cords, which indicates 67 years' supply. New Brunswick, with 36,000,000 cords of spruce and balsam, and an annual cut of 1,250,000 cords, has sufficient for a twenty-nine years' supply.

**Sea Lion Leather.**—Large numbers of sea lions on the British Columbia coast which destroy annually vast quantities of fish food may be slaughtered and their hides placed on the world's leather market, if a proposition which comes from Premier Oliver and has the approval of many experienced fishermen, is carried out. The sea lion weighs from 2,000 to 2,500 pounds, the hides being nearly an inch thick. These hides make a tough and durable rough leather such as is used in workmen's gloves and in saddles. It is stated that these animals will eat 50 pounds of fish in a day. Four hunters recently killed several hundred sea lions in one day in the Charlotte Islands.

**Traveling Railway Car Exhibit.**—One method of advertising, as effective as the use of motion pictures, is the railway car specially fitted to display merchandise, according to British business men. Accompanying this car (or cars) should be a salesman able to speak the language of the country where the car is traveling and capable of demonstrating the articles exhibited. Even if parts of a model of an agricultural implement or machine be shown, the salesman ought to be able to get a complete machine from a central agency or warehouse in the country where the exhibit is being made and show the practical working of the machine. It appears a demonstration would be a good selling argument. However, most manufacturers are not so bulky or difficult to handle as farm machinery. To make sure of reaching business men, farmers and artisans, the coming of the Railway Car Exhibit is widely advertised in newspapers and on bulletin boards. Thus far the results in attendance and interest manifested have been beyond the most sanguine hopes of the promoters of the scheme.

## Shall the Corn Fields Run Our Cars?

The Possibilities of Synthetic Fuels, and the Source of the Alcohol to Make Them

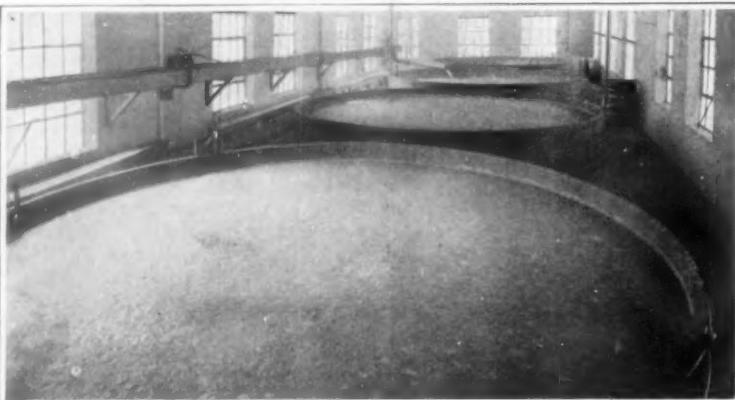
By Robert G. Skerrett

**A**LCOHOL will inevitably play a part of steadily increasing importance in our economic life. For many years it has been indispensable to the industrial arts in one way or another, but from now on it will figure more and more in furnishing heat and motive energy. Indeed, the students of the subject realize that we cannot begin too soon to develop our sources of alcohol and to adapt our internal-combustion engines and other apparatus to the use of this liquid fuel.

If one will take the trouble to study the array of advertising matter having to do with automotive vehicles it will be plain that the engineer and the inventor are busy trying to get an augmented service out of a given quantity of "gas." This end is being sought either by the development of auxiliaries of a wide variety or by modifications of the engines so that they can work to better advantage when fed gasoline of lower quality. This procedure is, in a sense, a sop to expediency and does not scientifically strike right at the kernel of the problem.

The manufacture of internal-combustion engines, insofar as the art is directly related to the utilization of gasoline, is in much the same state as was the fabrication of heavy cannon before the evolution of modern smokeless propellants. In the days gone, the ordnance engineer had to design his gun so that it would be strong enough to withstand the gases suddenly and violently generated by black powder. The controlling factor was a mechanical mixture of salt-peter, charcoal, and sulfur. As far as lay in their power, the metallurgist and the gunmaker joined forces, and together larger rifles were turned out capable of holding the explosive gases safely in check. But there was a limit to progress in the matter of weapons using black powder just as there is in the building of engines relying entirely upon gasoline for their impulse.

Next came smokeless powder, a chemical product, and from then on the ordnance engineer was unfettered: he can now pattern his rifle to give definite performances in the way of range and initial velocity. Having designed his gun, he turns to the man of the laboratory to provide a smokeless propellant which will function in complete harmony with the physical characteristics and the intended purpose of each type of cannon. And, let it be said, that in the same general manner we must cease to rely upon gasoline, pure and



Part of a group of vats in which the fermentation of corn into alcohol is carried on

simple, as a primary source of power and, instead, adopt composite fuels which the chemist will compound for us to meet stated conditions. In these alcohol is sure to figure conspicuously.

Six years ago, a synthetic fuel was brought out in South Africa and subjected to a series of tests which gave excellent results. The fuel was made up of about 60 per cent alcohol, 39 per cent ether, 1 per cent ammonia, and  $\frac{1}{2}$  per cent of arsenious acid. The purpose of the ether was to increase the "kick" and to make it possible to start an engine when cold. The ammonia neutralized the corrosive exhaust of the

alcohol so that it would not injure exposed metal surfaces, and the arsenic was to denature the mixture.

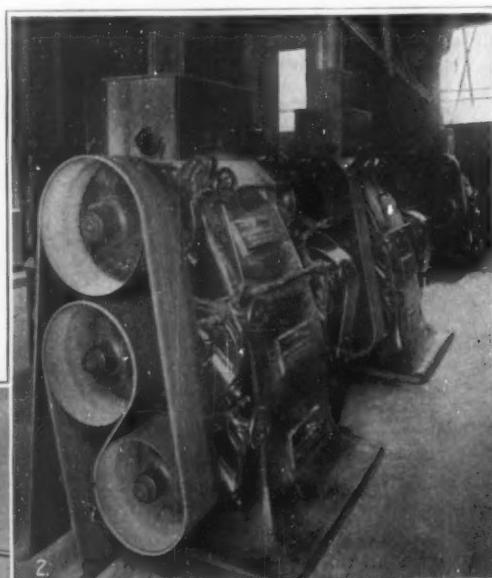
A synthetic fuel invented in this country has been perfected for airplane service. This is composed of 38 parts of alcohol, 19 parts benzol, 4 parts toluol, 30 parts gasoline,  $7\frac{1}{2}$  parts ether, and  $1\frac{1}{2}$  parts of some ingredient which is not disclosed, probably a denaturant. The fuel, during a trial period of several weeks, proved to be more economical than high-test aviation gasoline. The carbon deposit was less than is normally the case, and there was a reduction in the amount of lubricating oil required. Composite fuels, as we have them now, are helping to carry us along during the interval of transition from the out-and-out gasoline engine to a motor which may be developed that will be able to use straight or nearly straight alcohol. In either event, the result will be the evolution of engines

having superior characteristics; and the fuel, synthetic or otherwise, will be prepared to suit the motor instead of largely dominating its mechanical get-up as now.

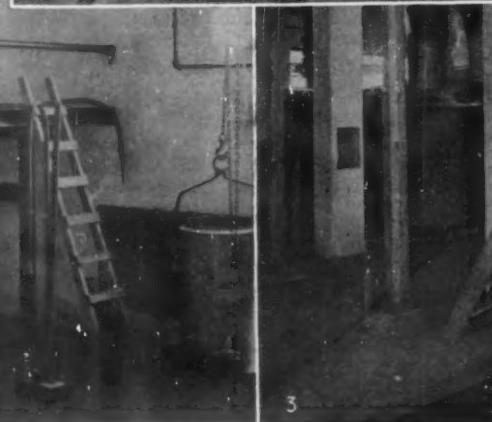
It is a matter of pretty common knowledge among those familiar with the liquid fuel used in automobiles and trucks that benzol is added to some grades of gasoline to improve their deficient "kick," and this ingredient is said to check carbon deposits. Toluol also augments the energy factor. Both benzol and toluol are coal-tar derivatives, and can today be had in immense quantities from our by-product coke ovens and from up-to-date gas houses. But even so, the layman may wonder where we are going to get all of the alcohol that may be needed when we come to depend less and less exclusively upon gasoline.

Hitherto, most of our so-called industrial alcohol has been obtained from sugar-mill waste, i.e., the well-known blackstrap molasses. The amount of this basic raw product is decreasing, mainly because the refiners have brought into play processes which make it possible for them to secure from the molasses various marketable syrups to satisfy the popular sweet tooth. True, low-grade molasses can still be had from the sugar mills of the Far East and other remote sources, but this entails the service of special tank steamers and the added costs of transportation. How, then, are we to produce the great measure of alcohol which we shall want ere long?

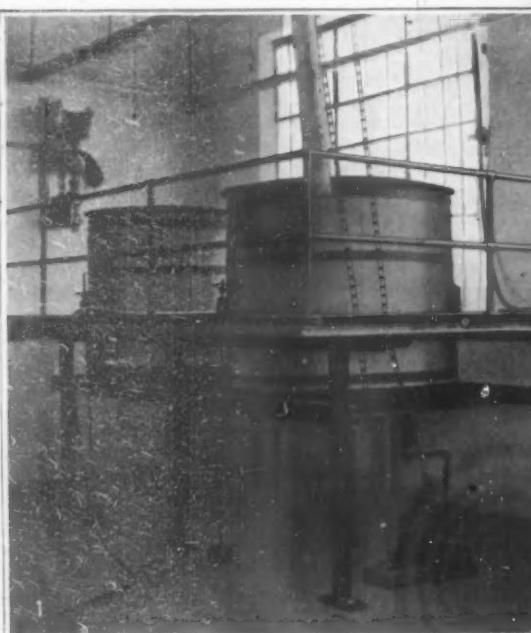
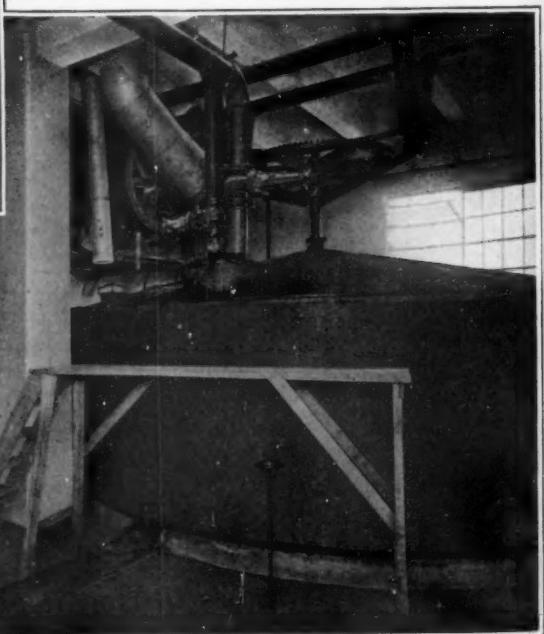
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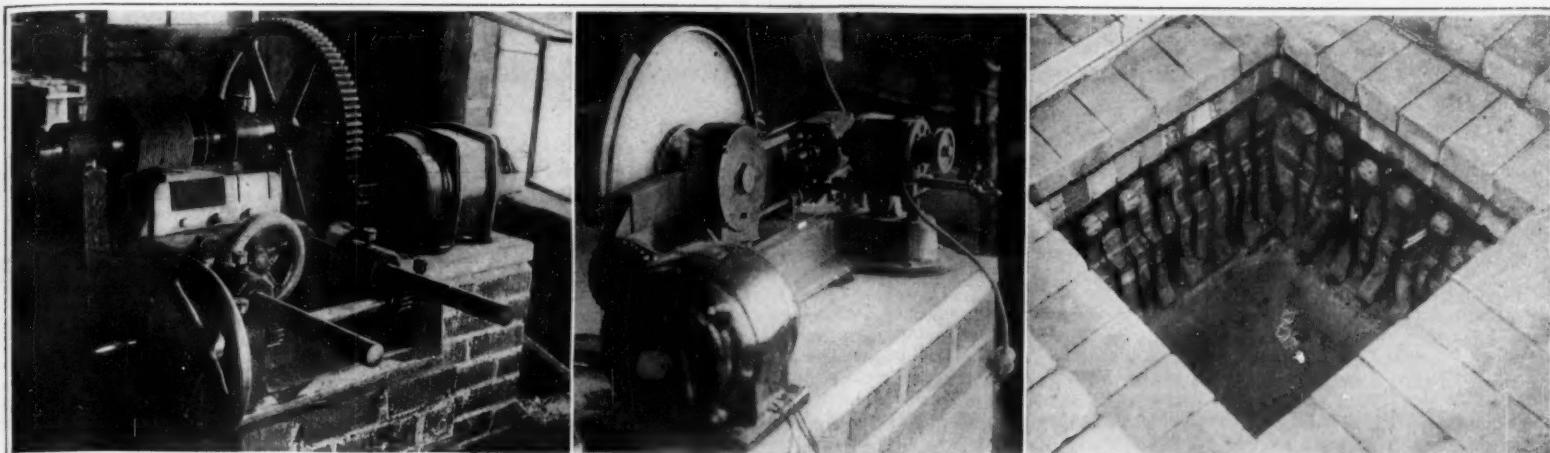
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3



Left: Vat in which the yeast is prepared to promote the fermentation. Above: Mills for grinding the corn preliminary to cooking. Right: The steam cooker where the ground grain is made into a mash in order to convert the starch to sugar  
Three steps in the extraction of alcohol from corn



*Left:* In this machine the sections of shale are sawed into pencil-like strips for subsequent shaping into needles. *Center:* The grinding machine for shaping the needles. *Right:* The electric kiln in which the shaped needles are heated to 2,000° Fahrenheit, in order to give them the proper hardness. Note the strips around the sides of the kiln, which comprise the heating element

#### From clay to phonograph needle via various machines and the tremendous heat of the electric furnace

##### Clay Needles for the Talking Machine

By Allen P. Child

THERE seems to be no end to the various kinds of phonograph needles. Playing records with a chip of a brick is the latest in phonograph needles—and the invention of an Iowa man. It is claimed that this needle of clay will play, with a very clear tone and with little surface noise, at least 200 times.

The needles are made from a dark red or chocolate colored shale. As the shale has practically no grain, and no grit is present, it is found that a very high polish is taken on where it comes into contact with the record. In making the needle the shale is cut from a bank in sections which are as nearly square as possible and each piece measures about 6 inches. The shale is brought from the clay banks and the sections are stored in sacks coated with paraffine. These sacks serve to keep the air away from the shale as it is liable to air check if exposed to the air when in a moist condition.

The sections of shale are then placed in an electric drier where it is dried very slowly. After thoroughly dried each section is clamped in a vise and is run through a saw which cuts it into pencil shaped strips  $\frac{3}{4}$  inches in length and  $\frac{1}{8}$ -inch square. The shale pencils are placed on a pallet and are fed automatically into the needle machine where they are pushed out through the head where they come into contact with a grinding wheel with 10,000 revolutions per minute. As they leave the head each pencil revolves at about 600 revolutions per minute. The grinding wheel turns each pencil to a perfectly round needle.

After projecting about  $\frac{3}{4}$  of an inch each pencil comes in contact with another grinder which is set sideways and a perfect point is turned on the needle. A high speed cutting wheel trims the needles to the required length after they have left the grinding machines.

After being placed in fire clay containers they are put in an electric kiln. In the kiln the heat is gradually increased to 2,000 degrees Fahrenheit. Needles are removed when the kiln has cooled sufficiently. The shale vitrifies perfectly at this temperature and is of a dark red color. If not over burned in the kiln the needles are of exceptional hardness.

##### The Rocking of a Tall Chimney

THERE used to be, and possibly still is, in certain quarters of Glasgow, Scotland, where are two of the tallest chimneys, a belief that the tops of those chimneys in high gales of wind swayed as much as 3 feet each way. Both these chimneys are built of brick. The oscillation of a chimney shaft taller than either of the Glasgow ones, built of reinforced concrete, at Saganoseki, Japan, has been carefully watched and measured by a Japanese engineering professor, says a writer in a British trade paper. The shaft is 570 feet in height and has a diameter inside at the top of 26 feet 3 inches. The wind velocities during the observations ranged from one mile per hour, a gentle zephyr, to a hurricane of 78 miles an hour. According to the professor the amplitude of the vibration at

the top in a 50-mile wind was no more than 1 inch, that is to say something and nothing, about half an inch each way.

In the 78-mile wind, however, the amplitude was 7.32 inches as a maximum, and curiously enough the movement was not in the direction in which the wind was blowing, but at right angles to that direction. The professor calculates that in a gust of 110 miles an hour, which not infrequently occurs, the amplitude would be at least 15 inches. It is interesting further to note that the time taken for each complete vibration was practically the same whatever the velocity of the wind, the range being merely from 2.52 seconds to 2.56 seconds.

##### Fuel Value of Wood

THE fuel value of wood has been the subject of more than one discussion and the following therefore may be of interest. A ton of coal may be taken as the equivalent in heating value of one cord of heavy wood, such as hickory, ash, oak, elm, beech, locust, birch, cherry, long-leaf pine, and hard maple. One and a half cords are required of short-leaf pine, Douglas fir, red gum, sycamore, soft maple, and western hemlock to equal a ton of coal, while in the case of cedar, cypress, catalpa, basswood, redwood, poplar, spruce, and white pine, two cords are equivalent to one ton of coal. Resin in wood gives twice as much heat as the wood itself, which accounts for the fact that the pines and firs have more heating power per ton than non-resinous wood.

It is to be understood that fuel value depends not alone upon heating power, but upon rapidity of burning, ease of ignition, minimum smoke, and uniformity in heat. Pines give a quick, hot fire and are consumed more rapidly than birch, birch giving a more intense flame than oak, while oak is noted for the steady heat it produces.

##### Putting the Payroll on an Automatic Basis

By Charles Abbott Goddard

MANY are the milestones of progress along the course which has transformed the old-time office where all writing and computing were done by hand, to the business workshop of today with its battery of typewriters and adding machines, its equipment for duplicating letters and forms of all sorts, its steel filing cabinets, and its private telephone switchboard. "Push the button and the machine does the rest," is a principle that has had marvelous adaptation to every phase of business routine.

A product of this age of office efficiency which has proved its worth is a machine which adds making out the payroll to the long list of business details now accomplished with mechanical ease. For years one of the most trying tasks for every company with a large number of employees has been making up the weekly or monthly payroll.

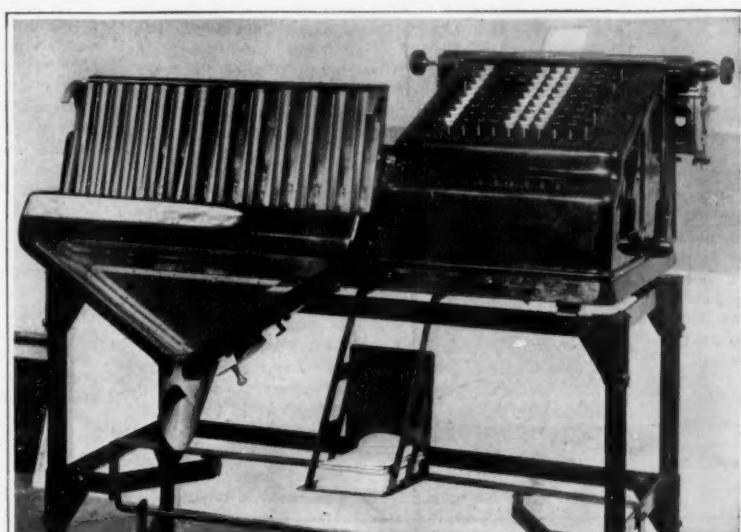
Although the advent of the adding machine brought considerable relief in this work, there were still many chances for mistakes in handling the cash. Checking up a great number of envelopes already filled to find the error was a tedious business at best. The adding machine assured the accurate adding of the payroll, providing the necessary sub-total and totals, but its usefulness ended when it came to denominating the payroll and actually filling up the envelopes.

Now comes a machine that solves all of the paymaster's problems at once. It operates like a standard adding machine in so far as it adds and lists the payroll, giving the grand total and sub-totals. But it does not stop there. The next step it performs is to denominating the payroll, that is, to indicate exactly how many twenties, tens, fives, ones, half dollars, quarters, dimes, nickels, and cents must be drawn to pay correctly. This is so long and tedious a job that many cashiers and paymasters simply approximate these denominations, carry an extra change account and balance the cash when the payroll is finished. This entails extra bookkeeping and the possibility of having to hold up the entire payroll to send out for more coins if those of any denomination are exhausted.

The payroll machine eliminates this entire problem by indicating instantly when it gives the payroll total, in just what denominations this amount must be drawn to pay each item correctly. The cashier can thereby draw the total payroll amount in exactly the denominations that will be needed, knowing that when the last envelope is filled the last cent will be used.

This remarkable machine goes still further. When the money is on hand the scheduling device is replaced by a coin tray into which all coins, gold or silver, are placed. The operator then runs off each payroll item on a keyboard similar to the standard adding machine keyboard. Each time the operator lists an item and pulls the handle the machine automatically counts out the correct amount of coin and drops it into the employee's envelope, at the same time making a permanent

(Continued on page 284)



This machine, based on the general principle of the adding machine, reduces the erstwhile tedious task of preparing the payroll to a simple mechanical operation

## New Concepts of the Past Century

The Change in Outlook Since Classical Days, Which Makes Non-Euclidean Geometry a Possibility

By the Einstein Prize Essay Editor

**T**HE science of geometry has undergone a revolution of which the outsider is not informed. The classical geometer regarded his science from a narrow viewpoint, as the study of a certain set of observed phenomena—those of the space about us, considered as an entity in itself and divorced from everything in it. It is clear that some things about that space are not as they appear (optical illusions), and that other things about it are true but by no means apparent (the sum-of-squares property of a right triangle, the formulae for surface and volume of a sphere, etc.). While many things about space are "obvious," these need in the one case disproof and in the other discovery and proof. With all their love of mental processes for their own sake, it is then not surprising that the Greeks should have set themselves the task of proving by logical process the properties of space, which a less thoughtful folk would have regarded as a subject only for observational and experimental determination.

But, abstract or concrete, the logical structure must have a starting point. It has been pointed out in these columns that the simplest words cannot be defined in terms of anything still simpler. In any logical structure they must therefore stand undefined. Equally, the simplest facts cannot be proved in the absence of simpler facts to cite as authority. If we are to have a logical structure of any sort, we must begin by laying down certain terms which we shall not attempt to define, and certain statements which we shall not try to prove.

The classical geometer sensed the difficulty of defining his first terms. But he supposed that he had met it when he defined these in words free of technical significance. "A point is that which has position without size" seemed to him an adequate definition, because "position" and "size" are words of the ordinary language with which we may all be assumed familiar. But today we feel that "position" and "size" represent ideas that are not necessarily more fundamental than those of "line" and "point," and that such a definition begs the question. We get nowhere by replacing the undefined terms "point" and "line" and "plane," which really everybody understands, by other undefined terms which nobody understands any better.

In handling the facts that it was not convenient to prove, the classical geometer came closer to modern practice. He laid down at the beginning a few statements which he called "axioms," and which he considered to be so self-evident that demonstration was superfluous. That the term "self-evident" left room for a vast amount of ambiguity appears to have escaped him altogether. His axioms were axioms solely because they were obviously true.

### Laying the Foundation

The modern geometer meets these difficulties from another quarter. In the first place he is always in search of the utmost possible generality, for he has found this to be his most effective tool, enabling him as it does to make a single general statement take the place and do the work of many particular statements. The classical geometer attained generality of a sort, for all his statements were of *any* point or line or plane. But the modern geometer, confronted with a relation that holds among points or between points and lines, at once goes to speculating whether there are not other elements among or between which it holds. The classical geometer isn't interested in this question at all, because he is seeking the absolute truth about the points and lines and planes which he sees as the elements of space; to him it is actually an object so to circumscribe his statements that they may by no possibility refer to anything other than these elements. Whereas the modern geometer feels that his primary concern is with the fabric of logical propositions that he is building up, and not at all with the elements about which those propositions revolve.

It is of obvious value if the mathematician can lay down a proposition true of points, lines and planes. But he would much rather lay down a proposition true at once of these and of numerous other things; for such a proposition will group more phenomena under

a single principle. He feels that on pure scientific grounds there is quite as much interest in any one set of elements to which his proposition applies as there is in any other; that if any person is to confine his attention to the set that stands for the physicist's space, that person ought to be the physicist, not the geometer. If he has produced a tool which the physicist can use, the physicist is welcome to use it; but the geometer cannot understand why, on that ground, he should be asked to confine his attention to the materials on which the physicist employs that tool.

It will be alleged that points and lines and planes lie in the mathematician's domain, and that the other things to which his propositions may apply may not do lie—and especially that if he will not name them in advance he cannot expect that they will do lie. But the mathematician will not admit this. If mathematics is defined on narrow grounds as the science of number, even the point and line and plane may be excluded from its field. If any wider definition be sought—and of course one must be—there is just one definition that the mathematician will accept: Dr. Keyser's statement that "mathematics is the art or science of rigorous thinking."

The immediate concern of this science is the means of rigorous thinking—undefined terms and definitions, axioms and propositions. Its collateral concern is the things to which these may apply, the things which may be thought about rigorously—everything. But now the mathematician's domain is so vastly extended that it

**W**HEN the Einstein essays begin to appear in print, it will be found that many of them will have something to say about the non-Euclidean character of the geometry of the Einstein four-dimensional time-space manifold. This sounds like a very large order but it is not half so bad as it sounds. The competing essays, however, will not be able, in the space allotted, to give this phase of the subject anything like the background which it ought to have. It seems that such background may properly be supplied in advance rather than as an afterthought; so the Einstein Prize Essay Editor has prepared the accompanying material which, with another article in a later issue, aims to make it plain just what the mathematician is getting at when he talks of non-Euclidean geometry. We have asked this member of the staff to try to make good on the boast, which he recently incorporated into a review of Einsteinian literature, that he tries to be a human being. We hope that he has succeeded.—THE EDITOR.

becomes more than ever important for him to attain the utmost generality in all his pronouncements.

One barrier to such generalization is the very name "geometry," with the restricted significance which its derivation and long usage carry. The geometer therefore must have it distinctly understood that for him "geometry" means simply the process of deducing a set of propositions from a set of undefined primitive terms and axioms; and that when he speaks of "a geometry" he means some particular set of propositions so deduced, together with the axioms, etc., on which they are based. If you take a new set of axioms you get a new geometry.

The geometer will, if you insist, go on calling his undefined terms by the familiar names "point," "line," "plane." But you must distinctly understand that this is a concession to usage, and that you are not for a moment to restrict the application of his statements in any way. He would much prefer, however, to be allowed new names for his elements, to say "We start with three elements of different sorts, which we assume to exist, and to which we attach the names A, B and C—or if you prefer, primary, secondary and tertiary elements—or yet again, names possessing no intrinsic significance at all, such as ching, chang and chung." He will then lay down whatever statements he requires to serve the purposes of the ancient axioms, all of these referring to some one or more of his elements. Then he is ready for the serious business of proving that, *all his hypotheses being granted*, his elements A, B and C, or I, II and III, or ching, chang and chung, are subject to this and that and the other propositions.

### The Rôle of Geometry

The objection will be urged that the mathematician who does all this usurps the place of the logician. A little reflection will show this not to be the case. The logician in fact occupies the same position with reference to the geometer that the geometer occupies with reference to the physicist, the chemist, the arithmetician, the engineer, or anybody else whose primary interest lies with some particular set of elements to which the geometer's system applies. The mathematician is the tool-maker of all science, but he does not make his own tools—these the logician supplies. The logician in turn never descends to the actual practice of rigorous thinking, save as he must necessarily do this in laying down the general procedures which govern rigorous thinking. He is interested in processes, not in their application. He tells us that if a proposition is true its converse may be true or false or ambiguous, but its contrapositive is always true, while its negative is always false. But he never, from a particular proposition "If A is B then C is D," draws the particular contrapositive inference "If C is not D then A is not B." That is the mathematician's business.

The mathematician is the quantity-production man of science. In his absence, the worker in each narrower field where the elements under discussion take particular concrete forms could work out, for himself, the propositions of the logical structure that applies to those elements. But it would then be found that the engineer had duplicated the work of the physicist, and so for many other cases; for the whole trend of modern science is toward showing that the same background of principles lies at the root of all things. So the mathematician develops the fabric of propositions that follows from this, that and the other group of assumptions, and does this without in the least concerning himself as to the nature of the elements of which these propositions may be true. He knows only that they are true for any elements of which his assumptions are true, and that is all he needs to know. Whenever the worker in some particular field finds that certain group of the geometer's assumptions are true for his elements, the geometry of those elements is ready at hand for him to use.

Now it is all right purposely to avoid knowing what it is that we are talking about, so that the names of these things shall constitute mere blank forms which may be filled in, when and if we wish, by the names of any things in the universe

of which our "axioms" turn out to be true. But what about these axioms themselves? When we lay them down, in ignorance of the identity of the elements to which they may eventually apply, they cannot by any possibility be "self-evident." We may, at pleasure, accept as self-evident a statement about points and lines and planes; or one about electrons, centimeters and seconds; or one about integers, fractions, and irrational numbers; or one about any other concrete thing or things whatever. But we cannot accept as self-evident a statement about chings, changs and chungs. So we must base our "axioms" on some other ground than this; and our modern geometer has his ground ready and waiting. He accepts his axioms on the ground that it pleases him to do so. To avoid all suggestion that they are supposed to be self-evident, or even necessarily true, he drops the term "axiom" and substitutes for it the more colorless word "postulate." A postulate is merely something that we agree to accept, for the time being, as a basis of further argument. If it turns out to be true, or if we can find circumstances under which and elements to which it applies, any conclusions which we deduce from it by trustworthy processes are valid within the same limitations. And the propositions which tell us that, if our postulates are true, such and such conclusions are true—they, too are valid, but without any reservation at all!

### What May We Take for Granted?

But how does the geometer know what postulates to lay down? One is tempted to say that he is at liberty to postulate anything that he pleases, and investigate

(Continued on page 286)

## Shortening the Route from Farm to Consumer

### One Way to Do This by Reversing History and Extending the Rôle of the Farm

By John T. Bartlett

SOME farmers only crop the land, as in grain farming and orcharding; a greater number both crop the land and raise livestock, utilizing the feed produced; a very small number crop the land, turn the crops into livestock products and then process the livestock products for consumption by the consumer. Are economic conditions such in America at present that there is an opportunity for the farm which is a complete factory, turning out a finished consumer product? This is a debatable, but important question.

Certainly such practice cannot become general in all branches of farming at present, since it would involve the milling of grain, the packing of meats, and the cooking and canning of fruits and vegetables on a scale which only a ridiculous minority of our growers could possibly contemplate. Even so, however, the dairy industry and the associations of fruit growers which have sprung up in various parts of the country show a tendency to undertake just this task on a co-operative scale; and here and there we find cases where the individual farmer is going in for a complete handling of his product. One \$300,000 farm enterprise in the Northwest is predicated on a belief that the time is opportune for a type of large farm which performs every step, except retailing, in the production and distribution of such staples as butter, eggs, and all kinds of meats.

This is a property of 2,500 acres, intensively developed for the past ten years. It has a poultry plant which at times has held as many as 4,000 head. The intention is to standardize at 8,000 head. Dairy barn facilities are for 200 head of cows. The hoghouse has a capacity of 2,000 head. These are large-size buildings, as farm structures go, but not especially unusual. The interesting thing is that the farm equipment

goes much further. It includes a \$35,000 packing house, built in 1911 of tile and concrete and with a complete equipment all the way from slaughter room to storage. There is a creamery which has a capacity of 60,000 pounds a year.

Several score years ago both creameries and packing houses were unknown in the twentieth century sense. Butter was formerly wholly made on farms; now it is made in large or small creameries, some owned by co-operating farmers and others by private interests. Before cream is manufactured into butter nowadays it typically travels anywhere from several miles to two or three hundred from the point of production.

The same thing has happened in meats. Beef, pork and mutton were once slaughtered, cut up and cured on the farm where produced. Then came local slaughter houses and finally the great centralized packing plants of the present day. Farmers still do considerable slaughtering for home or neighborhood use, but practically no other. There was a time when the farm was a complete farm factory, and when its functions were not complete until it had prepared the product for the consumer. The whole trend of the times has been away from this condition.

Now, with the development of a higher level of merchandizing ability among farmers will farm enterprises which go back to the old function—with a difference—become extensive? Do economic conditions provide a place for such farms?

The experience to date of the Washington project is not conclusive. The farm has demonstrated one thing, that in its particular case it is not practical to cut out the retailer, building distribution on the parcels post. The original intention was to do this, and an

extensive mail trade was built up, but the plan proved unprofitable. The present arrangement is distribution through the retailer. A retail store in Tacoma specializes in the farm's products; the farm trade-mark is featured, and a lunch counter is made an effective trade-builder. Working along these lines, the management believes its methods are economically sound.

On the other hand, a New England farm near Springfield, Mass., having a smaller output than this one in the Northwest, has established a system of consumer routes. A wagon carries eggs, butter and vegetables in summer and in winter these and such home-made country products as hulled corn, hominy, sausage meat, jellies, pickles. The farm is very careful in selecting a salesmen. No ordinary farmhand will do. He must know how to sell, and how to build up good will. He is paid a salary and commission.

Again, one of the largest mixed farms in New Hampshire has for years eliminated all middlemen and marketed direct to the consumer, but here the consumer is a large Boston hotel which owns the farm. Butter, meats, fruits, etc., are produced. It is understood the farm thus operated is profitable. A big chain restaurant with establishments in many eastern cities did the same sort of thing for many years.

In all such methods to shorten the distance between farm and consumer, management is a critical factor. No plan of doing business is "fool-proof." There must be clever, shrewd management behind it to make it a success. The fact that many attempts to market in a new way have failed is indubitably partly attributable to the fact that inexperienced people have launched many such ventures.

## Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

### Some More Newspaper Astronomy

To the Editor of the SCIENTIFIC AMERICAN:

I was much interested in the article you had some weeks ago about the misinformation that was published in the Albuquerque paper. I ran across one yesterday in the *Los Angeles Times* that seems to me even worse, and thought you might appreciate it. It occurs in the "Questions Answered" column of this sheet, and is in reply to an inquirer who wants to know why the moon isn't always round. The oracle tells him:

"The moon is always round, but its changes in appearance are due to the earth's shadow being thrown upon it as the earth passes between the sun and the moon. The size of the shadow varies each night that the moon is visible."

It would seem that this explanation leaves something still to account for. So far as I know the earth is always the same size, and therefore it seems rather extraordinary that its shadow should vary in magnitude. Also, why the reservation about the nights when the moon is visible? Are we to suppose that no moon is merely a total eclipse?

Still, we shouldn't be too hard on him. Doubtless the same member of the *Times* staff attends to the astronomical queries and the advice to the lovelorn, and too great accuracy should not be expected of one who adopts such widely divergent specialties.

Los Angeles.

A. E. T.

### Protect the Standing Train

To the Editor of the SCIENTIFIC AMERICAN:

I would respectfully ask, in view of this last terrible accident on the New York Central, if it would not be pertinent to again call attention to the absolutely criminal carelessness of leaving the rear of a standing train unprotected, as well by derail as by signal. A train might run by signals, but never by a well-placed derail.

If not in this case, the particulars of which are not at hand, certainly in most cases, there is time to place a derail in addition to the ordinary signals, and sel-

dom would a derailed train work the havoc to itself that it would by crashing into the rear of a standing train.

GEO. T. PAINE.

Waterville, Me.

### Pure Water at Low Cost

To the Editor of the SCIENTIFIC AMERICAN:

Inasmuch as the question of pure water is an important one in every household, and as the supply of pure water is not always available, I will briefly outline a simple means of obtaining the purest of water (distilled) at a minimum of cost and with no other appliances than those found in the average kitchen.

I use an aluminum tea-kettle and a quart glass milk bottle. I have the milk bottle tilted so that its bottom is about six inches above the lid of the kettle, the neck of the bottle passing over the spout of same. Very little heat is required to keep the water in the kettle at a boiling point, and the condensation, drop by drop, will amount to a quart, without interfering in any way with other kitchen work.

Inasmuch as the ordinary means of distillation is complicated and expensive, this simple way in which I obtain absolutely pure water is worth passing on.

Rhinelander, Wis.

J. C. TEAL.

### The Origin of Coastal Ripple Marks

To the Editor of the SCIENTIFIC AMERICAN:

Permit me to ask the attention of the author of the article on the *Geology of Ripple Marks*, and of your readers, to a theory I have reached during ten years of study of the method of their formation.

It has seemed to me that these markings are usually, if not always, caused by water driven upshore by the ocean waves and the forming of little pools or lakelets in depressions of the sand by the lowering tides. As the tidal ebbing continues the water in the little ponds seeps through the sand, seeking the lowered level of the adjacent water. In doing so the scales of hornblende and quartz are sorted, compacted, and wrinkled by the currents of sinking sea-water into the characteristic contortions and ripples. An admixture of mud in the higher levels results in the larger and more contorted wrinkles.

Atlantic City, N. J.

GEO. M. GOULD.

### Life on Mars?

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of March 20th the insistent problem of life on Mars is attacked by a correspondent, C. Fitzhugh Talman, an avatar of Martian habitability.

Mr. Talman writes in fine conservative vein as he seeks to "revert to sanity on the subject." He summarily dismisses the possibility of biological evolution on Mars, stating that "nothing we know of the evolutionary process warrants such an assumption."

I deny the validity of this sweeping assertion, and thereon join issue with Mr. Talman.

Nearly every biologist knows that, glowing in the photospheres of distant suns and buried in the soil of alien planets, there exist the same chemical elements that compose the organic creations on this earth—sodium, nitrogen, calcium, carbon, oxygen, et cetera. When a planet cools to the "terrestrial" epoch, as the late lamented Doctor Percival Lowell termed it, these chemicals are brought into play in the planet's life history.

Mammalian structures, increasingly complex and elaborate, originated in the depths of our hot primeval oceans, later to emerge upon the land areas. In even the "least propitious milieu" they found the means of sustenance and growth, and forthwith proceeded the drama of life on our planet.

True, the latitude within which Nature can adapt her creatures is generous, yet Huxley's protoplasmic life-molecule only functions and survives within limits from 32° Fahrenheit to 107.6° Fahrenheit at the upper extreme. Exposure for brief periods to higher temperatures, such as 150° F. and 160° F. in Death Valley is possible, but generally tends to evaporate the water in the tissues and congeal the albumen in the bodily fluids.

Now, Doctor Lowell demonstrated from Merriam's survey of the San Francisco peaks in Arizona that the maximum summer temperature during the breeding season to which high mammalian orders were exposed—not the rigors of winter cold—determined the possibility of survival. He furthermore showed that the climate of Mars must resemble that of an elevated plateau in a desert region such as Arizona.

Several years previously Arthur Stentzel, analyzing the problem on mathematical grounds, arrived at a mean annual temperature for the poles of Mars of about +12°F.—far higher than its distance from the sun implies. But as summer comes on, the temperature at the Martian equator rises to the mean annual value of 98.1°F. or ten degrees higher than the earth's. This amply included and justified the upper limit determined on less exact data by Doctor Lowell in his work, "Mars as the Abode of Life" a few years previous.

San Francisco, Cal., U.S.A.

DONALD P. BEARD.

## Running the Gauntlet of Quality Production

The Tests That an Automobile and Its Parts Have to Meet Before Passing from the Factory

By Ralph Howard

INDUSTRIAL Europe has long recognized with grudging admiration the cheapness and speed of American standardized quantity production. It has in general felt itself unable to compete with our methods, but has comforted itself with the belief that these methods could never equal the supreme quality of jobs produced by the hand-fitting work of their skilled mechanics.

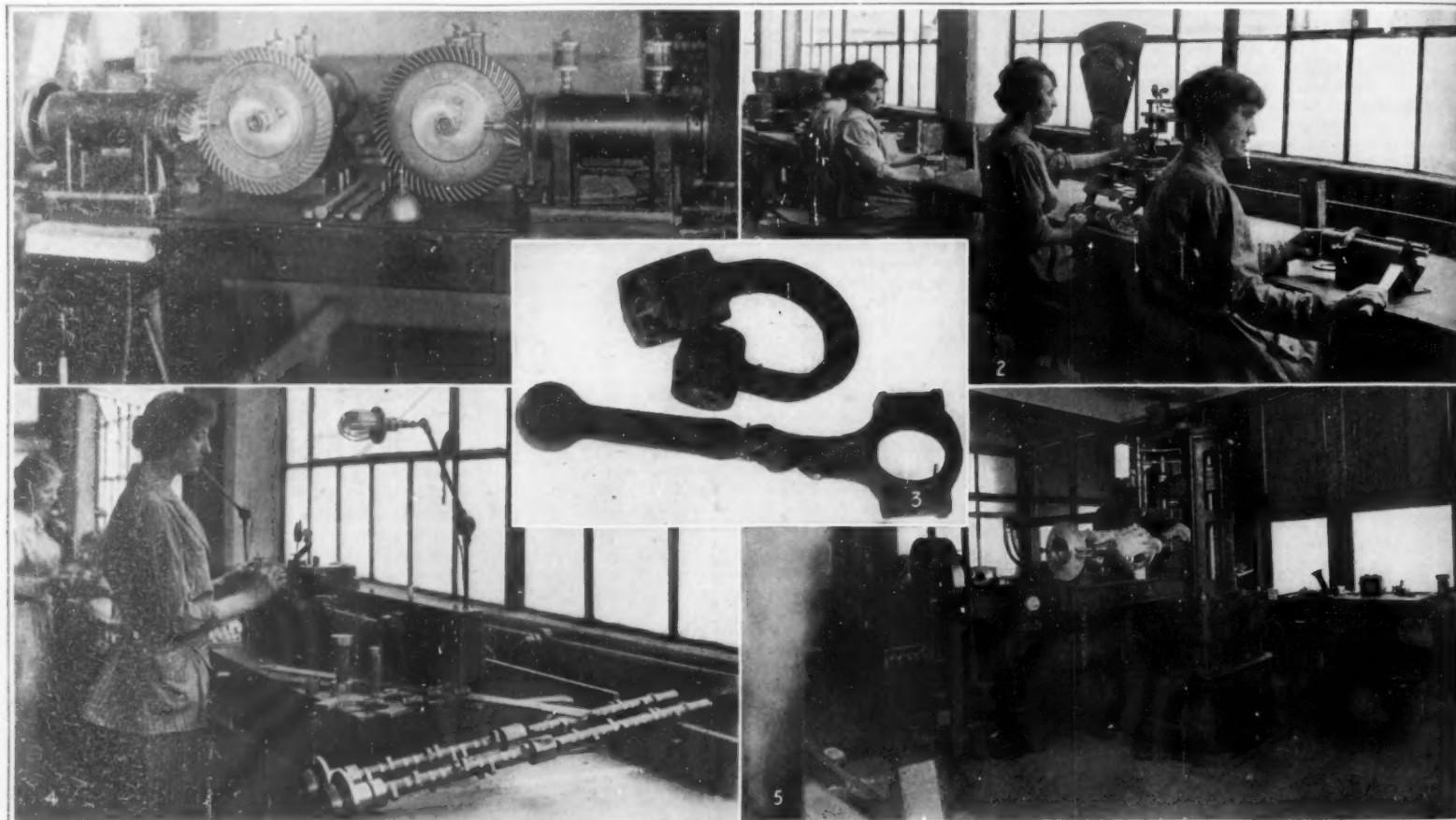
This was true for a time, but is true no longer. American shops are now turning out work which is both standardized and of supreme quality. There is a considerable number of our factories which can produce goods equal in every way to the best Europe has ever made, and with the added advantages of standardization. American watches are now equal to the Swiss, American machine-made shoes are as good

There are about 2,300 individual parts put into a big passenger car, ranging all the way from the tiniest screws to the two-hundred-pound cylinder-block castings. The magnitude of the task of having each one of these parts come to the assembly line perfectly fitted to take its place with any other part chosen haphazard from the stock bins can be seen. Yet it is accomplished by a wide and rigid system of inspection under which it is almost impossible that any unfit part can reach the stock rooms. The errors that occur are negligible; they are always corrected by the further inspection of the assembled product that finally takes place.

The extreme degree of accuracy which is insisted upon in the machining of parts is shown by the limits of tolerance which are permitted on inspection. These

accuracy is one of the most costly, as it is the most necessary, factors in quality production. Approximately one employee in every twenty is an inspector, and in addition minor executives, like the jobsetters, have definite inspection functions. The mass of gages necessary is staggering. There is a total of some 15,000 in constant use; of these 3,000 are to a thousandth of an inch, and they are kept accurate by constant inspection which brings each one to a testing machine about once every three weeks. It is needless to say that with such accuracy demanded on inspection of parts, there is a most careful inspection also of drills, jigs and bushings, to insure that inaccuracies do not creep in during machining.

All inspection is by blue print specifications, and for many of these inspections special gages and profile



1. If the gear does not run noiselessly when tested on this motor it is rejected. 2. Testing piston rings for width, thickness, resilience, and accuracy of fit. 3. Bending and twisting tests applied every little while to connecting-rod blanks taken at random from stock. 4. Gaging cam-shafts to insure that they will give accurate timing. 5. Crushing an axle-housing in a machine capable of exerting a pressure of 100 tons

A few of the many tests that make the automobile the reliable, standardized machine that it is

as the English hand product; American machine tools lead the world.

Recognition of this advance in the quality of our production has come very slowly, even at home. Abroad it has barely begun to appear. The reasons for our success are little understood, yet they are simple, and when once known show why our methods not only do produce the highest possible work, but must inevitably do so. They are a skilful combination of science and art, applied rigorously to industrial processes. Perhaps the best illustration of this, because of the wide range of work done, the large number of operations involved and the severe tests to which the product is put, is to be found in the automobile industry.

Under the old system a skilled man achieved accuracy in the assembly by making each part fit the part with which it was to work. The final touches were by hand. The fit could be made exact. Under the modern method there are no final touches to be put on when the parts come to the assembly lines. They have been finished with such accuracy that each will fit into place perfectly without further attention, and fit as well as by any possible skilled adjustment.

of course vary widely; it would be merely extravagance to demand hair-like accuracy in a door-latch, or a profile accurate to the thousandth of an inch in the fan. But to say of the machining of the working parts that they were merely accurate to a hair's breadth would be a libel. Many of them are four or five, and some ten times, as accurate as that.

In one car tolerances that come within a thousandth of an inch are too numerous to list. There are 331 of them—and each of these is an accuracy to half the thickness of the finest human hair. Of these 81 are on the rear axle and brakes, 29 on the steering gear, 72 on the clutch, 102 on the motor and 47 on the transmission. But there are nineteen processes which are permitted a tolerance of only half a thousandth; there is one that is held to three ten-thousandths, there are three to .00025 and two to two ten-thousandths of an inch. These tolerances are, for practical purposes, absolute. They cannot be exceeded except in the laboratory, at carefully fixed temperatures, since the heat of the hand will cause a variation of at least a ten-thousandth of an inch in a three-inch standard steel measuring block.

To maintain the inspection which will insure such

forms have to be used. So small a thing as a valve, for instance, is inspected on nine different points. The slot is tested for width and length. The stem is ring-gaged for its entire length. A profile gage is used to test the length and the angle of the face. Both the face and the end of the stem are tested on the scleroscope for hardness. There are 24 such valves to each engine—a total of 216 inspection operations for the engine valves alone.

The steering rod calls for 26 inspections, and a total of 43 inspection operations, since several tests have to be made at different points. There are six tests on each piston ring. Each of the 60 teeth on a transmission gear is tested separately, not to mention the inspection for other points on the gear.

The cam shafts show how complicated the inspection must sometimes become. These are steel shafts, about three feet long, with bearings at either end and a gear at one end, and with two dozen cam wheels. Each of these wheels must be tried in a special gage to insure accuracy of eccentricity and accuracy of placement for timing; each must be tested on both faces for hardness. The tolerance on the machining is one thou-

(Continued on page 288)

### Coasting With Wheels Instead of Runners

**I**T appears that coasting is pretty much of an all-year-round sport in Switzerland. Indeed, no sooner does the snow disappear and the warm weather is well under way than the sled is replaced by a small three-wheeled coaster of the general type shown in the accompanying illustration. This vehicle is steered by means of a simple handle controlling the single front wheel. A set of brakes operated by foot controls serves to check the speed during the downward rush over the smooth roads.

### Raising Two Million Baby Trees

**F**ROM the moment the tiny seeds are placed in beds until the bedraggled "monarch" of the forest yields to the storm and stress of years, trees are not impervious to the undermining depredations of insects and rodents. Mindful of this fact, Uncle Sam establishes safeguards around the seed bed as well as jealously guards the grown-up trees in the National forests.

Acreage devoted to sprouting young trees for transplanting 7,000 acres of land annually is covered with fine screening as a protecting influence against insects and rodents that would uproot the otherwise promising crop. A type of screen recently devised for this purpose is so constructed that the sides as well as the top are detachable, thus permitting of storage in compact space when the screening is not in use.

Seeds selected for perpetuating the National forests are assembled by the U. S. Forest Service the previous fall for planting the following spring. Germination tests are first made to determine the vitality of the seed, after which they are sown in beds at a rate sufficient to yield about 150 trees to the square foot.

Ordinarily, Uncle Sam replenishes his diminishing stock of trees in the National forests at a rate of 1,000 young trees to the acre. Couple this fact with the production of 150 trees to the square foot in the seed bed and you can calculate the mileage of screenings used in safeguarding the plant life from its enemies.

The seeds are brought to fruition in large nurseries, the photograph showing a seed bed with a capacity for producing about 2,000,000 plants. The view is of the Savenac Nursery in Lolo National Forest, Montana.

### Can We Fire-Proof Aerial Mail?

**T**HE Witticism of the experienced aviator, "Flying is perfectly safe—that is, unless you happen to fall," is taken literally in a re-fashioned adaptation by the United States Post Office Department in establishing safeguards around the aerial mail service. Disastrous crashes of mail-transporting machines at Baltimore, Cleveland and elsewhere, resulting in the loss of postal pouches from fire, have proved canvas cloth thoroughly immersed in sodium silicate to be ineffectual in protecting the mails. Consequently, the one-piece asbestos container has been adopted for installation in twenty parcel-carrying airplanes. Ten yards of asbestos cloth, with an equal measurement of khaki cloth, of 12-ounce weight, is the composition of the fire-resistant material. The asbestos cloth is of substantial quality, weighing 2½ pounds to the square yard, and the container is bound together with 1,500 copper rivets. It is made secure in the airplane by thin steel strips and screws having great power. Asbestos buckles and straps are used in fastening the mail in the compartment of the plane. The baggy covering has a capacity for snugly enclosing eight of Uncle Sam's largest No. 2 mail pouches, affording protection for 320 pounds of postal matter. The maximum capacity of mail-carrying planes is 620 pounds. Three different types of asbestos containers are being installed. Twelve DeHaviland planes, six of the new type R-4, and two of the old type R-4 machines are being equipped with containers. The containers are being constructed by the Mail Equipping Shops in Washington.

A series of tests has been conducted by officials of the Post Office Department at its landing field,



With the advent of warm weather the Swiss tourists abandon the sled and turn to the three-wheeled coaster

College Park, Maryland, to determine the reliability of the containers in safeguarding mail from conflagrations. A pouch of dummy letters, enclosed in the asbestos covering, placed in a barrel of shavings which



One hundred and fifty trees to the square foot are raised in these screened-in plots of ground, or a total of two million plants at Montana U. S. Forest Survey nursery

had been soaked in a gallon of gasoline, then applying the torch, was the basis of the experiment. After being subjected to intense heat for twenty minutes, the mail was removed. With the exception of the



In burning a pouch of dummy letters enclosed in asbestos for 20 minutes, only the edges of several packages of letters were charred

Fire-resisting qualities of an airplane mail bag

packages of letters on the outer edges of the container being charred, the mail was practically intact.

A spraying apparatus for shooting fire-extinguishing liquid in the mail, gas and engine compartments of the airplane; an automatic ignition interrupter, and the placing of an asbestos bulkhead between the gasoline and other compartments of the plane—these are the fire-resisting precautions designed to increase the efficiency of a mail service that is hazardous at best.

### Spoilage of Corn

**I**T is well known that every year thousands of tons of sound corn deteriorates or spoils during storage and transportation. According to one authority, during a period of four months in one year the deterioration of corn arriving in the Chicago market exceeded the value of four million dollars, and the problem of keeping meal in a state suited for human consumption has long been a problem. In view of these circumstances, a study has been undertaken at the Kentucky Agricultural Experiment Station. The conclusions state that excessive moisture is the principal cause of deterioration and spoilage of corn. If the moisture does not exceed twelve per cent, sound grains can be preserved for a considerable time. Such grains will readily absorb moisture if exposed to air in which free moisture exists, and molds, which cause the very rapid deterioration of oil and starch in corn will develop on grains containing fifteen per cent of moisture even at normal temperature if the ventilation is inadequate.

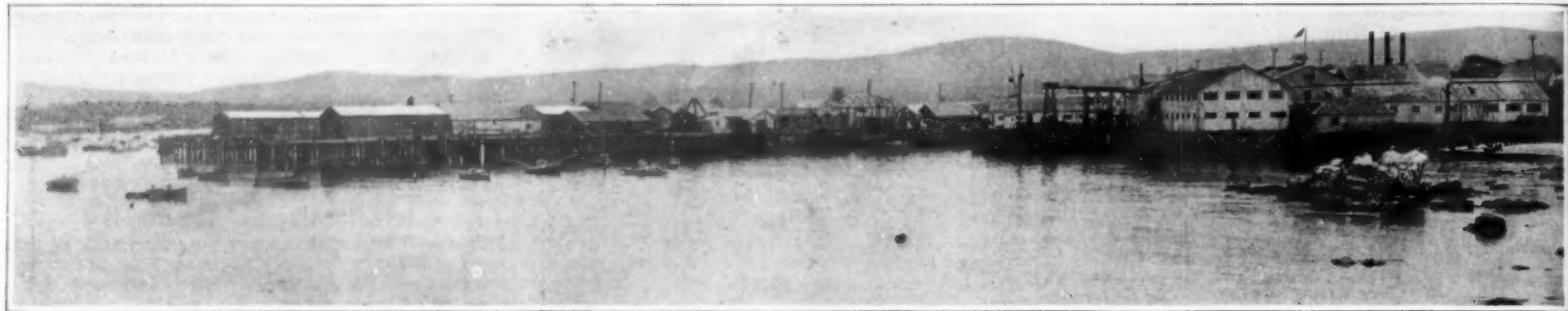
If twenty per cent of moisture be present fermentation, producing alcohol and acetic acid, takes place under similar conditions. The danger during exportation is probably due to the failure to dry the corn before placing it in the holds and in not keeping the moisture below twelve per cent during the voyage.

In the case of corn meal, the germ seems to contain an easily oxidizable substance which, when exposed to the atmosphere, produces an acidity, which however will not develop if the corn meal is deprived of its moisture. If the temperature is lowered the development of acidity is retarded. Meal made from degenerated grains is inferior to that made from whole grains and

the latter, if it does not contain over twelve per cent of moisture, can be kept away from moisture and held in a condition fit for human consumption for some four to six months.

### A Fire Caused by Water

**A** FIRE which was somewhat unusual in its origin occurred the other day in a dwelling-house in England, says a writer in an English paper. It started in the fusebox containing the fuses for the various lighting circuits in the home. The box was attached to the kitchen wall, and immediately above it ran the two pipes supplying the hot-water system. When the kitchen fire was out, the water in these pipes was, of course, cold, so that they acted as a surface condenser on the kitchen atmosphere, and a steady drip of condensed water took place down the kitchen wall. The pipes were whitewashed, and the condensed water in consequence carried with it a certain amount of calcium carbonate, which destroyed the rubber insulation of the conductors at the point where they passed from the metal tubes in the wall into the fusebox. In turn the copper conductors were corroded with the formation of copper carbonate, and finally the section of wire remaining was so small and its resistance became so great that it got red-hot with the current passing, and set fire to the insulation, spreading ultimately to the woodwork of the fusebox. Fortunately, the failure of the lights gave warning and allowed the fire to be extinguished before any serious damage had been done, but if it occurred in middle of the night, when a light was switched on for a few moments only, the results might have been very different. Of course, no good electrical engineer would place a fusebox or any electrical apparatus on a wall which was liable to dampness, but in these days, when so many people are calling themselves electrical engineers with nothing more to support the claim than an elementary knowledge of wiring, the householder cannot be too careful.



Sardine fishing and canning plant on Monterey Bay, California

## From Fish to Food

How the Toothsome Sardine Is Prepared for the Market by Regular Factory Methods

By Arthur L. Dahl

**B**IG industries, as well as big events, grow out of little things. The sardine is probably the smallest fish utilized for food, and yet the canning of this toothsome morsel is developing into a very large industry on the Pacific Coast. We have often heard of a tall wagging the dog, and the sardine industry is a case in point, for its beginning in southern California grew out of the exigencies of another fish-canning industry—that of the tuna. Tuna fish are large, very undependable in habits, and although canned tuna is a strong rival of the salmon, the conditions surrounding the tuna-packing plants were very unstable. There was either a feast or a famine of the big fish, and to stabilize conditions somewhat the packers turned their attention to utilizing some of the small fish caught by the fishing fleet operating in the vicinity. The first sardine canning was done merely as a side issue, to keep down overhead, but its development has been so rapid that now the sardine industry outranks that of salmon fishing in many parts of the West Coast.

The type of sardine packed on the Pacific Coast, is larger than its eastern cousin, or those of European countries, but the meat is fully as good in flavor and texture, and the western sardine is rapidly coming into favor because, the fish being larger, more food can be bought for the same amount of money charged for the smaller fish of the East.

The sardine occurs in great abundance along the entire west coast of the United States and southward on the coast of lower California. It is taken the year

round and is especially abundant from September to December. It spawns in the spring. It is an oily, delicately-flavored fish that resembles very closely the European sardine.

The principal sardine fishing-grounds are off the Coronado Islands, in La Jolla Bight, off Redondo, at Santa Monica, Newport and around Santa Catalina Island, in southern California, and in and about Monterey Bay and at Santa Cruz in central California. A number of commercial sardine-packing plants have been established near the fishing grounds, and in these plants the most modern equipment has been installed for cleaning and canning the tiny fish.

Off the coast of Maine, where numerous packing plants are located for the handling of sardines, the fish are caught largely by the use of weirs, but in California this method cannot be used because the coast sheers off into deep water. There are no flats and no places to put weirs, and the only way one can get sardines is to go out with nets. The Japanese and Italians are especially efficient and go out just before daylight, and by the phosphorescent gleam in the water can encircle a school of sardines and bring them in. Sometimes they get so many they cannot land them in the boat. To prevent the fish from being mutilated by piling them too deep in the fishing boats, various

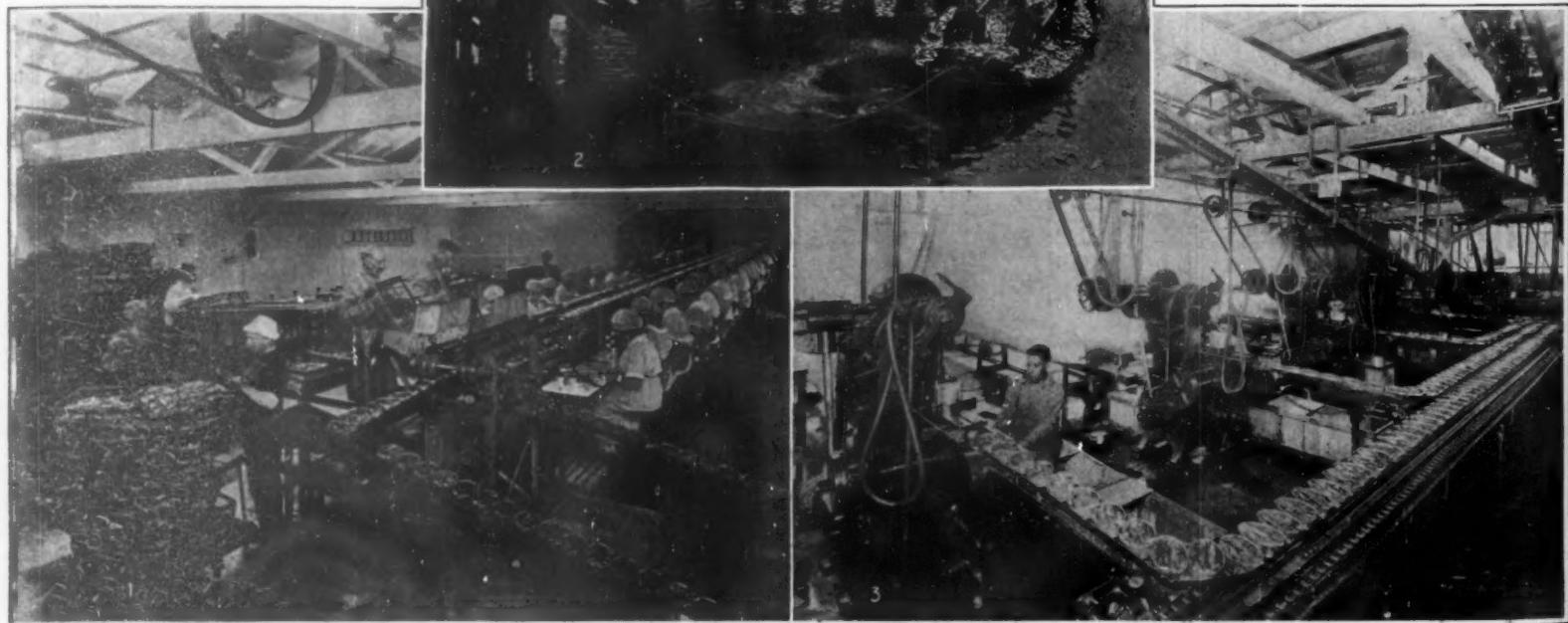
regulations have been promulgated by the fishing authorities limiting the height of the fish in boats.

The sardine fisherman ordinarily use a round haul or circle net, about 1,200 feet long, 50 feet deep in the wings and 150 feet deep in the bag. A line of corks are fastened along the upper edge and a lead line along the lower edge. The mesh ranges from  $\frac{1}{2}$  inch in the bag to 3 or 4 inches in the wings.

The net is kept in the stern of the boat, and when a school of sardines is sighted one end of the net is let out and the boat circles about until the net is entirely out and the two ends are close together. It is then slowly drawn in by hand until all of the fish are forced into the center of the bag of the net, where it is an easy task to scoop them out with wire scoops.

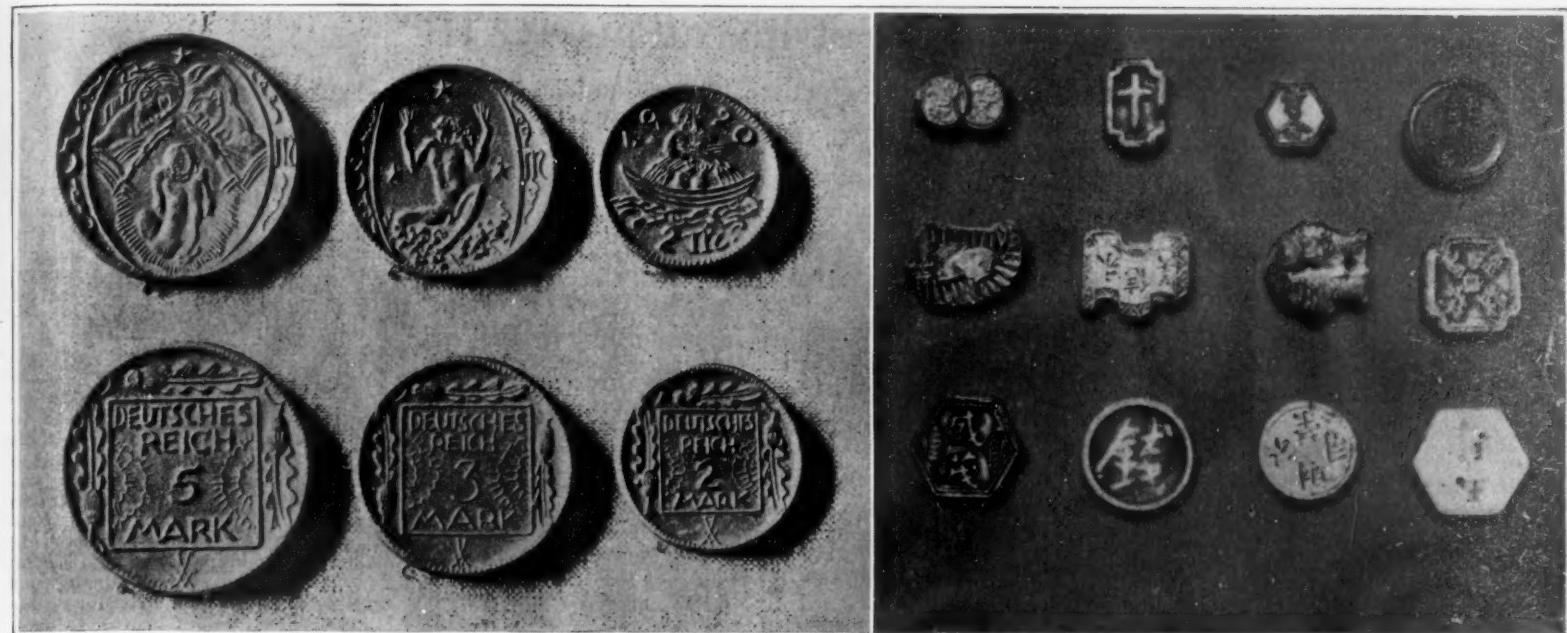
At first the fisherman would merely dump the fish into the boat to a consid-

(Continued on page 290)



1. Filling the cans with the raw sardines; the upper conveyor brings the empty containers to the girls, and the lower belts carry away the filled cans. 2. Where the sardines come from—hoisting a catch from fishing boats to cannery. 3. Clamping on the lids. The boxes are carried on the belts to and through the capping machines, and with hardly a pause on to the cooker.

Three stages in the process of converting sardines from fish to canned food



Left: German "biscuit" porcelain coins, 2, 3 and 5 mark pieces. Right: Siamese porcelain tokens issued by gamblers but prohibited in 1871

### German Porcelain Money—An Old Idea Revived to Offset Cheap Marks

IT is now proposed to issue coins in Germany of a denomination of 2, 3 and 5 marks of porcelain. The mark has depreciated to such an extent that it would hardly pay to coin it in anything more valuable than copper or iron, and porcelain seems to be an excellent medium of exchange. Municipal coins particularly for use on cars, "tram currency," are now in use in Hamburg and other cities. The factory facilities are large at Meissen and there is nothing specially to make at present so that there seems to be no reason why porcelain coins should not be manufactured at the erstwhile plant that turned out vases and wonderful dinner sets. The coins are very sanitary, as to clean them it is only necessary to throw into water. Owing to the technical plant required for their fabrication—we cannot say minting—they are very difficult to counterfeit. Porcelain coins are not new, as two of the old English potteries adopted "china" or porcelain tokens. They were made at Worcester in denominations of one and two shillings. In 1801, five and seven shilling tokens were issued at Pinxton. These were oval in shape, flat on one side and convex on the other side, which bears the value in large figures. They were called "chang" or "chanu" money, a dialect corruption of the word Chinese.

It is the oriental use of porcelain for coinage which possesses the most interest. Siamese porcelain tokens were in use from the middle of the 18th century until 1871 when they were forbidden. The majority of these pieces were issued in Bangkok, largely by gambling houses, the fraternity at that time having an enviable reputation for honesty! There are at least 890 known kinds. They occur in a great variety of shapes, colors and values. The denominations are on the reverse and are generally in blue. The native name of this currency is "Pl." The inscriptions are usually in Chinese as the gambling houses were usually owned and operated by Chinese.

The origin of the coins or tokens is interesting. Gamblers in Siam squatted down on an oblong mat at one end of which the cashier or *croupier* was seated in a kneeling attitude. The coins which changed ownership so frequently were thrown a considerable distance, and, being bullet-shaped, often rolled in the wrong direction. To remedy this the owners introduced special counters like the well-known "chips" with which the average red-blooded American is entirely familiar. In time porcelain was adopted and the

use of the counters was gradually extended to general use as they were issued under authority granted in the gambling license or concession. So they rapidly became a medium of exchange and were found to fill a long-felt want for small money, but the circulation went beyond its legal sphere. Counterfeits soon made their appearance and the gamblers made constant changes in the size, shape and colors for they are found in round, oval, star, lozenge, gourd, leaf, butterfly, bat and fish shapes. Finally the government interposed and would not allow the tokens to circulate as money although they probably still pass muster in the games of "fan-tan" or whatnot which so interest the Celestial. There is a large collection of these tokens in the Museum of the American Numismatic Society in New York. For our photographs we are indebted to our valued English contemporary the *Illustrated London News*.—By A. A. Hopkins.

### What Automobile Racing Does to the Delicate Machinery Called Man

WHEN Gaston Chevrolet climbed from his little green racing car after winning the 500-mile International sweepstakes automobile race at Indianapolis recently, after having driven steadily for nearly six hours at the average speed of 88.16 miles per hour, his eyes were almost lifeless. In medical phraseology they were "dead." His face was haggard and drawn. The muscles of his legs and forearms were cramped and knotted. His head drooped and his steps faltered.

In fact he looked like a man who had just taken a dose of poison.

And that is exactly what happened!

The strain of clutching the wheel of his car for more than five hours and forty minutes, never once relaxing his hold or taking his eyes off the dizzy white

stretch of brick pavement always ahead of his speeding machine, had caused physical fatigue equivalent to poison, for fatigue is defined as poison by prominent medical authorities. And fatigue poison is just as effective in its action as arsenic or carbolic acid. An overdose of either would be fatal.

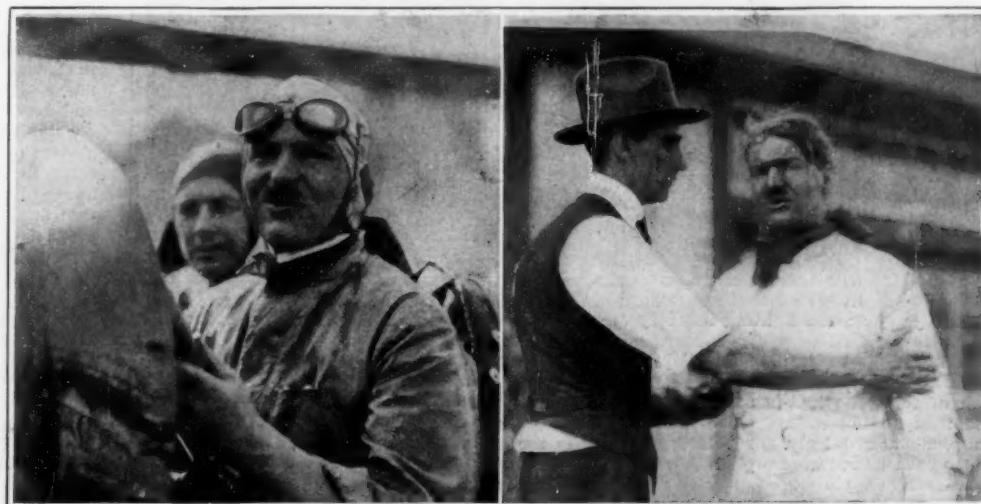
The accompanying pictures tell the story of Chevrolet's complete exhaustion. One shows him, fresh, alert, smiling and full of energy, ready for the grueling 500-mile race. The other shows him, gaunt, and haggard of face, with colorless eye, drooping head, sagging body and cramped muscles, as attendants helped him from his car after the race, and assisted him to his garage. It is hard to believe that the two pictures are of the same man—yet a period of only slightly more than six hours elapsed between their taking.

"The extreme exhaustion suffered by Chevrolet from physical exertion and severe strain of driving 500 miles without a stop at the terrific speed he maintained," declares Dr. Clyde Leeper, a medical expert of Akron, Ohio, "caused certain chemical changes to create poisonous decomposition in the muscles of his body—in other words the production and accumulation of waste substances such as carbon dioxide and lactic acid. In large quantities these are typical fatigue poisons."

"Chevrolet after the race had the 'dead' eye which we found so often among wounded men overseas, among men who had endured long suffering from wounds and exhaustion and men who had become shell-shock victims. Chevrolet's extreme fatigue was equivalent to a severe shock to the complete nervous system—almost the same as if he had been hurled forty or fifty feet in an explosion, and severely stunned. Bicycle riders, marathon runners and long-distance swimmers suffer similar fatigue. They all have that 'dead' eye after the acid test of endurance."

Chevrolet's muscles were so cramped his fingers had to be pried loose from the steering wheel. Huge knots in the muscles of his forearms had to be massaged and rubbed down. And chemical action in his body, created by the extreme exertion and strain, caused him to lose several pounds during the race.

Other drivers suffer similar fatigue, many in shorter races. The faster the speed maintained, the more severe the physical strain. For instance, at Beverly Hills when Art Klein drove the 50-mile speed classic at the rate of 111.8 miles per hour, his fingers were clamped to the steering wheel so tightly they had to be pried off. He was powerless to relax the death-like clutch.



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The "before and after" of automobile racing: Gaston Chevrolet at the start of a 500-mile race, and just after winning it

## The Romance of Invention—XVII

### The Heart of the Gas-Filled Lamp—Ductile Tungsten and the Man Who Made It

By C. H. Claudy

**I**T is a conservative estimate to say that the use of the tungsten filament in the modern electric light saves two millions of dollars a day in current.

Behind that saving lies one of the most romantic stories of scientific research which can be imagined. The romance finds its roots in the fact that tungsten is naturally the most intractable of all metals, as for certain purposes it is the most useful. Almost it seems as if Nature defied the scientist and the laboratory to win it for man's use. Not only has it a higher melting point than any other substance (save only carbon), so that it cannot be melted or cast (since anything containing tungsten to be melted would melt before the tungsten), but the metal when produced as such in any other form than a fine powder exhibits characteristics of hardness and brittleness which defy the hammer, the lathe and the die.

Yet today we possess ductile tungsten. We make fine drawn wires of it; we make little disks of it which serve as contact points in our automobile ignition system; our modern X-ray tubes depend upon it.

Given a few ounces of finely powdered metallic tungsten, which cannot be melted in anything because "anything" will melt at a lower temperature than tungsten, how shall one make of it a solid metallic rod? Given a solid metallic rod of tungsten which will break if dropped upon the floor like so much glass, how shall one shape it, work it, draw it into wire?

That was the problem which Dr. W. D. Coolidge undertook to solve with the help of the great electrical laboratories at Schenectady and the resources of men, money and facilities freely provided for the search, because of the enormous commercial importance of the production of tungsten filaments for electric lamps, which would not break.

It would take pages, where here are available but paragraphs, to describe the long series of experiments which led to the final success, or more than to indicate the discouragements. The worst of the matter was that there was no knowledge in the beginning that search was not being conducted for something which didn't exist—every shred of evidence available seemed to point to the fact that tungsten was not naturally and never could be made ductile, that the hunt was a hunt for the non-existent.

But Dr. Coolidge had persistency and faith, with a firm belief that if there were no direct way there might be an indirect way; and through indirect ways he worked until he produced the finished article—ductile tungsten, now available, in wire and in rod, in block and in sheet for the purpose which only a metal of such a high melting point (3,000 degrees Centigrade) can serve.

The metal, in the form of a powder, produced by treating the oxide (obtained by chemical means from the tungstate of iron and manganese or from the tungstate of calcium, both of which occur in nature) with heat and hydrogen, is pressed in a mold to form a slender square rod. In this condition it can no more be picked up than can a slender square rod of wet sand. But like wet sand, it can be slid upon a slab, and if that slab be of molybdenum (a metal of the same family as tungsten and with a high melting point of its own) the whole can be inserted into an electric furnace and in an atmosphere of hydrogen raised to a white heat. Kept at this temperature for a sufficient length of time, the individual grains of the metal, while they do not melt, do draw together and become a semi-sintered body. Whether they weld or adhere each to each by surfaces only, makes no difference. The rod, slightly shrunk, can now be handled, though it is yet more brittle than glass and can no more be drawn or hammered than a stone.

The next process is to grip its ends in copper jaws, one pair a fixture at the top of a hydrogen container, the other floating in mercury at the bottom. Through the rod is now passed a current of electricity which heats it again, this time to a temperature just short of the melting point of the metal. The copper jaws at the upper end and the mercury at the lower are water-cooled to keep them from melting, but the rod between is white hot with a heat beyond any otherwise applied to any metal.

where at last it may be drawn, hot, through diamond dies, and come out the other side in the form of a fine wire, strong as steel and almost as flexible as copper.

There were tungsten filaments before ductile tungsten—processes of mixing the powder with an amalgam or some other binder and distilling out this binder from wire formed from the mixture, resulted in true tungsten wire, but wire which broke with a jar and shattered with a blow. Electric lamps made of such wire were resistive to the heat developed but could

no more be applied, for instance, to automobile headlights than glass could be used to make baseball bats. Not until tungsten was made ductile, not until the investigation and research under Dr. Coolidge demonstrated that what the life history of the tungsten group of metals seemed to say did not exist wanted only enthusiasm, determination and time for its complete discovery, did the modern tungsten-filament lamp become a possibility.

The American Academy of Arts and Sciences gave Dr. Coolidge the Rumford Medal for his work in producing ductile tungsten. Not one man in a million, perhaps, who reads by a tungsten light, who sees an electric sign or runs an automobile having an ignition system dependent for its operation on a little pair of tungsten contact points, or who has an X-ray picture made of what ails him with a tube that is efficient and powerful because it has a tungsten target at one end and a hot tungsten cathode at the other,

knows the name of the young man with the happy smile and the enthusiastic devotion to this work which has so greatly benefited the world. The scientific world knows, however, and the SCIENTIFIC AMERICAN section of the great American public is now told—Coolidge is the man who did it.

The search for ductile tungsten was conducted with the idea that it was the solution of the great industrial problem—the production of economical and efficient electric lights, possessing long life and ability to keep their candlepower well up during long use. But many other uses have been found for ductile tungsten, of which by no means the least important is its employment as the "target" or anode in an X-ray tube.

The X-ray tube is so much a special tool, confined almost exclusively to the physicians and the sick room, that those without broken bones or foreign bodies intruded into their living machines, or who fail to provide work for doctors by getting pneumonia or cancer or some other diseases which may be either investigated or treated with the strange light rays which pierce ordinary tissues almost as easily as sunlight does glass, know little about it. In the light of Dr. Coolidge's work with the tube, it may even be said that the scientific world didn't know much about it until he took hold of it and developed the hot cathode tube.

Prior to that time, a certain minimum amount of gas in the tube was essential to carry the current across the gap between anode and cathode. In the Coolidge tube the cathode is formed of a tiny spiral of tungsten wire which is heated by a current of electricity. When sufficiently hot, it emits electrons which carry the current impressed upon the terminals across the gasless gap between. Exhaustion of gas in the Coolidge tube is carried to as high a point as modern vacuum production can attain, with the result that puncturing troubles disappear, the focal spot no longer moves, and local heating of the glass is conspicuous by its absence. Moreover the intensity of the X-rays produced is easily and directly controlled by the amount of heating permitted in the hot cathode. High or low penetration may be obtained at will from the same tube, and, equally as important, one operator may exactly duplicate the conditions under

(Continued on page 292)



Dr. W. D. Coolidge, whose invention makes tungsten workable, revolutionizes the lighting industry and makes the X-ray an instrument of precision

"mering" is called "swaging" and consists of repeated blows of pairs of successive dies, each pair slightly smaller than its predecessor. A special swaging machine was devised expressly for this work, which regulates the blow to the exact weight necessary, and gives new shape to the rod by gradual steps.

Smaller and smaller gets the rod, and with each hammering, each heating and each decrease in size, it gets more and more tractable, until, when reduced to the size of the lead in a pencil it is in a condition

# The Motor-Driven Commercial Vehicle

Conducted by MAJOR VICTOR W. PAGÉ, M. S. A. E.

*This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles.*



Truck doing an emergency job in place of a disabled tractor

### Motor Truck as Tractor

THE motor truck is constantly proving its versatility and adaptability to all kinds of work on the farm. Not only is its usefulness increasing for delivery work on and about the farm but it has also demonstrated that it can work in uncultivated fields in case of an emergency. This is the discovery of William Berkenstock of Fullerton, California, who used a three-ton, four-wheel-drive truck to disk and sub-soil a ten-acre orchard, in which he was preparing to plant young citrus trees. When his tractor broke down and he was confronted with the task of disking the field before the trees arrived he hooked the disk on to the truck and dragged the entire tract with ease. While this is unusual work for a truck it demonstrates, nevertheless, its versatility and power in emergency cases and also brought out the tractive power of the four-wheel-drive principle in an unmistakable manner.

### Delivering Coal for \$1 Per Ton

THE big advantage of a motor truck in the coal business is that it brings the outlying sections of the city closer to the coal yards. A prominent firm of retail coal dealers of Brooklyn, New York, use a truck for delivering coal to residences, factories, stores and office buildings, most deliveries being to retail trade. This delivery has heretofore been considered most economical by teams, however, including all items of expense, the motor truck has been delivering coal for \$1.00 a ton.

The motor truck actually covers twice the radius of a team, and does the total work of  $2\frac{1}{2}$  teams. For instance, during one month recently, this machine made 91 trips, traveled 684 miles, and delivered 526½ tons of coal. In the same month the teams averaged but 325 tons. This average shows that the motor truck de-



livered 61 2/3 per cent more coal in spite of the fact that this tonnage was hauled twice as far as the horses traveled.

These motor trucks are loaded from overhead hoppers, and a 6-ton machine can be filled in seven minutes. Every morning the motor trucks are weighed to give the actual empty weight each day to subtract from loaded weight. This empty weight varies from time to time and the variation must be taken account of in order to give customers exact weight. The accompanying illustrations show how trucks can be used advantageously in coal hauling. One shows the hopper loading system that cuts down delivery costs, the other shows light trucks hauling lump coal.

### Veteran Truck in Grocery Service

A PROMINENT truck company frequently has said in its advertising that the useful life of its product has not yet been determined and this statement seems to be borne out by the performance of Truck "A," dean of the delivery fleet of a Cleveland house, which has entered upon its tenth year of daily service and bids fair to emulate the example of Mr. Tennyson's well-known brook and run on forever. While not the oldest truck of its make



Ten years old and still going strong

in operation today, a number of trucks antedating it in delivery, Truck "A" is unquestionably the veteran to remain continuously in the service of its original owner. It was in May, 1910, that this two-ton truck was delivered to the purchasers by the maker and immediately put into commission in charge of a driver who was a lover of fine machinery and at once made the truck his pride. So carefully did he care for the truck and so carefully was it driven, that in a little more than nine years but one slight mishap marred the record of truck and driver, though all of the work was performed in the midst of constantly increasing traffic perils in the growing city of Cleveland—a wonderful record which, unfortunately was ended by the death of the veteran driver a few weeks ago.

Originally the truck was used to transport goods between the company's three stores in Cleveland, in general

hauling from the depots, and in delivery service. When it was four and a half years of age, the owners estimated from the records kept that the truck had then covered 200,000 miles. Since that time a portion of the burden once borne by Truck "A" has been transferred to heavier trucks which have been added to the fleet, but it has easily added an additional 100,000 miles to its record and is today, according to the superintendent of delivery for the company, "in good shape and doing about forty-five miles per day."

This bears out the contention that has been made from time to time in these columns by the writer that more trucks are worn out by abuse than by use.

### Horses Displaced by Tractors

THE number of horses displaced by tractors in the corn belt is largely determined by the number it is necessary to keep for corn cultivation and other work current at the same time which the tractor cannot do. This is perhaps the most important of the facts brought out by an investigation recently made by the United States Department of Agriculture in seven corn belt states, relative to the influence of tractors on the use of horses, the results of which have been published in Farmers' Bulletin 1093.

The Department has drawn on the experience of 191 tractor owners in the preparation of this bulletin, which is designed to enable the corn belt farmer to answer for himself the following questions:

For what operations can I use the tractor?

In what operations will it displace horses in whole or in part?

How many horses will it displace on my farm?

It was found that the number of horses disposed of by the farmers in question after buying tractors was between two and three a farm. The average number of acres tillable by horses was increased 12 and the average size of the farms by a total of 22 acres. Several operators displaced horses entirely on plowing, disk ing and harrowing. Few operators allowed their horses to stand idle while the tractor was in use.

The tractors were used for an average of 29 10-hour days a year on the home farms, no records being taken of custom work. A three-plow tractor on these farms does the work of  $8\frac{1}{2}$  horses in plowing, disk ing, harrowing and harvesting.

The results of this study further substantiate the conclusion that the principal advantage of a tractor lies in its ability to do heavy work in a shorter time than is possible with horses.



Making good use of the truck in handling live stock

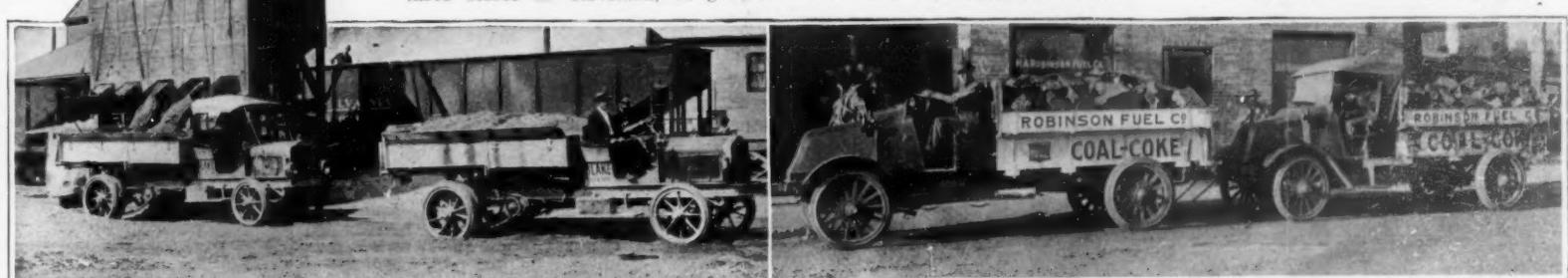
### Small Packers Aided by Trucks

IT is due to the successful operation of the motor truck as a live stock carrier that small packing centers are being established in different parts of the country. Packing centers shorten the haul to market as the products do not have to be hauled to distributing centers before being sent out to the ultimate market. This in turn has an important bearing on keeping the cost of meat down to a minimum. The live-stock grower instead of loading stock in cattle cars to ship to the different centers now hauls it to the nearest packing center in his motor truck, saving time and expense as well as delivering cattle and hogs in the same condition they left the farm. The consumer in the vicinities of these packing centers is able to get fresh meat at a price lower than if the meat had come a great distance. Thus it can be seen that the benefits of the motor truck are not just those that are directly attributed to it, but are benefits that redound in a greater area than is realized.

The accompanying illustration depicts one practical method of transporting live stock by small motor truck. The animal is carried in a special rack or crate that fits inside the main body and which can be loaded or removed without disturbing the live stock the truck is to carry. This simplifies handling the animals, especially when small and active, as sheep or swine are, and also protects the truck body from the filth inevitable in transporting live animals for any distance.

### Motor Trucks Help Small Towns

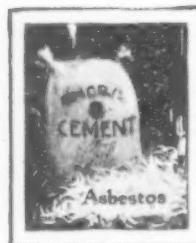
MANY a small town which for years has appeared to be doomed to oblivion because it was not lucky enough to get on a railroad line is being put on the map today, and the motor truck gets the credit. This new mode of transportation opens up markets both ways, making it possible for residents of these communities to ship their products at low cost to neighboring cities, and also brings to them the goods of the outside world, thus permitting a growth in population that would otherwise be impossible, especially in newly developed oil and mining districts.



Left: Rapid and economical delivery of the coal to the truck from the railroad. Right: The largest sizes of coal are economically handled by big trucks. The part played by the motor truck in cutting down the costs of the coal business



## Shingles of Asbestos beautiful, fireproof and economical



Asbestos Shingles should not be confused with asphalt or other so-called composition shingles manufactured to meet the demand for low-priced roofing material in the face of rising costs. Asbestos shingles have earned from the Fire Underwriters' Laboratories the high rating of Class A.

TWO considerations seem to be the basis of everyone's choice of a home roofing material—appearance and durability. And both are important.

Charm in a home roof is as necessary in its way as dependability and durability, for many good-to-look-at roofings fall far short of what might be called a perfect housetop specification. Tile, for instance, is heavy and costly; slate, if not expensive, is heavy and has certain limitations in color and weathering properties.

Even the wood shingle (the traditional house roof of America) is now challenged by the beauty of Johns-Manville Asbestos Shingles which are fireproof, and hence satisfy fully the fire authorities of the more than 114 cities that have prohibited the use of inflammable roofs.

Here, then, in asbestos shingles, we find the one roofing material that combines all the qualities that a perfect roofing should have.

Permanently durable and fireproof because they are actually made of rock (asbestos mineral fiber and Portland Cement) nothing organic in their composition to rot, warp or disintegrate under varied weather conditions.

Supremely artistic in their appearance, with all the soft tone values and weathering properties so lacking in other mineral roofs.

No wonder that both architects and house owners are pressing our factories to utmost capacity.

Johns-Manville Asbestos Shingles are easily laid in either the American or Hexagonal method of arrangement and in gray, brown, red or in the beautiful Colorblende assortment—the aristocrat of all roof coverings.

Throw a Johns-Manville Asbestos Shingle into a red-hot furnace. It will not burn.



JOHNS-MANVILLE CO.,  
Madison Ave., at 41st St., New York City  
10 Factories—Branches in 64 Large Cities  
For Canada:  
CANADIAN JOHNS-MANVILLE CO., Ltd.  
Toronto

Through—  
**Asbestos**

and its allied products  
INSULATION  
that keeps the heat where it belongs  
CEMENTS  
that make better walls lead proof  
ROOFINGS  
that cut down fire risks  
PACKINGS  
that save power money  
LININGS  
that make brooks safe  
FIRE PROTECTION PRODUCTS

# JOHNS-MANVILLE

Serves in Conservation

### Shall the Corn Field Run Our Cars?

(Continued from page 274)

In Germany nearly 70 per cent of the annual output of more than 100,000,000 gallons of alcohol is got from potatoes. In France, on the other hand, the chief source of industrial alcohol has been the molasses from the beet sugar refineries. Both of these basic raw materials are to be had in the United States in abundance, especially potatoes of the kind known to the farmer as seconds and culs, for which there is only a limited market. Potatoes that are unfit for food, because diseased or touched by frost, can be utilized in the manufacture of alcohol. A ton of the tubers, if they contain 16 per cent of starch, will yield 25 gallons of alcohol. Many millions of tons of potatoes are sacrificed yearly which could thus be profitably consumed in the distillation of motive spirits.

But probably the most promising native source of industrial alcohol is our vast corn belt; maize for years has stood pre-eminently as the cheapest raw stuff for the distillers. It is easy to raise, and stands transportation and storage admirably. It is undeniably true that wood waste is susceptible of furnishing a great volume of industrial alcohol, but there are difficulties of an outstanding nature which now seriously hamper putting any of the processes in service upon a commercial scale of moment. Similarly, recent developments in the field of chemistry have shown that it is entirely practicable to get a goodly measure of alcohol from the waste liquor of the mills engaged in the making of sulfite paper stock. The Germans are said to obtain quite 3,000,000 gallons of spirits from this origin annually; and the Swedes are employing a kindred method at thirteen of their sulfite mills—10,500,000 gallons of 100-percent-pure alcohol are thus realized in the course of a twelvemonth.

But alcohol in quantity enough for industrial and motive purposes is not to be had from by-product materials. We shall have to count upon an ample primary substance which can be cultivated for that purpose season after season. Here is where corn meets every requirement. It can be planted and harvested within ninety days throughout an enormous area; and a ton of the grain should yield about 80% gallons of pure alcohol. A large distillery should be able to handle 10,000 bushels of corn a day, and do this 300 days a year. That is to say, a plant of this size would have an annual output of 7,500,000 gallons.

In 1919 we grew 2,900,000,000 bushels of corn, representing a possible source of 7,250,000,000 gallons of alcohol. As a matter of fact, during the past year, our gasoline consumption amounted substantially to 3,100,000,000 gallons. Manifestly, then, if one-fourth of our corn had gone to the distillers of industrial alcohol we should have been in a position to get enough motive spirits to cut down the use of gasoline by fully 58.4 per cent. And if alcohol were used as the basis of a synthetic fuel such as those already mentioned, the mixture with ether, toluol, and benzol would effect a gasoline economy of quite 70 per cent in one case and 100 per cent that with ether alone.

The point to be kept in mind is that our farmers have it within their power tremendously to amplify the acreage planted in corn; and it has been suggested by the agricultural authorities that it would be possible to secure a still greater yield of alcohol if cornstalks were utilized. But this theoretical source of more motor spirits need not be considered because there are practical difficulties that stand in the way of putting laboratory revelations along this line to commercial use. Success in the manufacture of industrial alcohol rests fundamentally upon a sufficient and a continuous supply of the primary raw material, and, because of its keeping qualities, corn can be harvested and then held in storage where it can be drawn upon months thereafter. In this respect it is unlike a number of other potential vegetable sources of alcohol which can be turned to account for this purpose only during a comparatively short season.

Without going into the details of the making of alcohol from farm products, it will suffice to say that the first object is to convert the starchy content of potatoes, corn, etc., into sugar through the agency of fermentation; and as a further result of the action of the yeast the sugar is split up into alcohol and carbonic acid gas. Subsequent continued distillation separates the alcohol from the water with which it is combined, adding step by step to the strength or purity of the spirits.

According to present practice, little if any of the carbonic acid gas is saved from the fermenting mash, and right here exists a means of greatly lessening the cost of alcohol. A bushel of grain during treatment will give off seven pounds of  $\text{CO}_2$ . This gas has a ready market in the charging of bottled waters, beverages, etc., and for use at soda fountains. In fact, the present demand is far in excess of the supply. The  $\text{CO}_2$  liberated during fermentation is in its purest state and is superior to that made from marble dust, which has to be very carefully filtered, etc., to render it salable. Carbonic acid gas figures in refrigerating systems, and its fields of application are wide and varied. With a proper installation there is apparently no reason why this money-making by-product of the distilleries should not be conserved.

Lest there be a mistaken notion that a foodstuff as such is lost in the manufacture of alcohol from corn, it should be kept in mind that there is a fibrous residue or "slop" which contains 12 per cent of fatty matter and 33 per cent of protein. This, when dried in drums, looks not unlike middlings, and constitutes an excellent feed for hogs, cattle and chickens. The thin slop may, however, be fed to livestock by mixing it with roughage or by adding a proportion of the "middlings." This brings us to the story of a new fuel, which is rapidly growing in favor and finding many serviceable applications.

### Putting the Payroll on an Automatic Basis

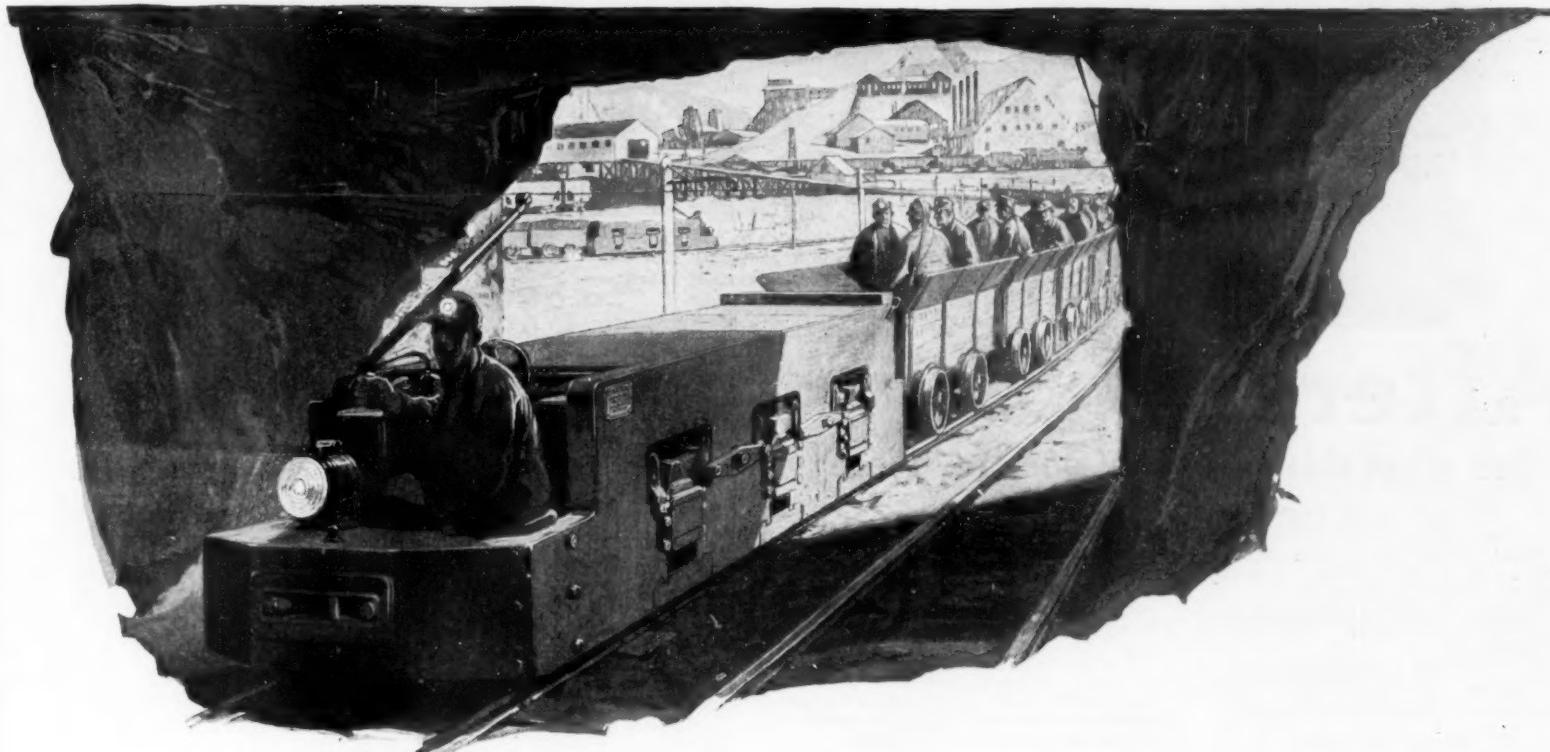
(Continued from page 275)

printed record of the amount put into each envelope. In using paper money instead of gold coin the procedure is slightly different but the results are identical. The payroll is thereby apportioned in a fraction of the time otherwise necessary and there is a printed record of the total amount put into each envelope. This record is perhaps the most important individual feature of the machine.

Under the old system, if an employee claimed that his pay was short it was practically impossible to check his claim once he had opened his envelope. Even though the cash had balanced after making out the payroll it was possible that some other employee might have been overpaid a similar amount. With the International payroll machine all such claims can be readily adjusted because the paymaster knows from his printed record exactly how much was put in each envelope. Even if the operator should make a double error, it will appear in the printed record. The machine thereby protects the employee against possible clerical errors and at the same time protects the employer against the claims of dishonest, careless, or mistaken employees.

When not required for payroll work, the machine can be used for adding and other computation in the same way as other visible adding and listing machines are used. This in no way interferes with the payroll mechanism which is connected or disconnected at the pressure of a key.

*In the basic industries of this country, without which other industries could not exist, electricity is the dominant factor in rapid and economical development.*



## The "Black Diamond" Miner's Best Helper

WHEN a coal miner clamps on his electric headlight, jumps aboard an "empty" and rolls smoothly along the "motor road" into the mine, his electric day has only begun.

Down in the mine, an electric spark ignites the blasting charge which tears away rock and opens the vein—an electric drill helps him cut his coal. While he works, electric light brightens all operation—electric pumps draw flood water from his path—electric fans supply him with fresh air, increasing his efficiency and protecting him from dangerous smoke and gases.

Small electric locomotives pull cars of coal to the main thoroughfares of the mine, where they are made up into

heavier trains and hauled to the tipple by more powerful electric locomotives. There a huge electric hoist lifts cars bodily and dumps the coal into the breaker to be crushed and screened into various sizes by electric motor-driven machines—and later dropped into railroad car or ship by the same operator throwing another switch on the electric control panel.

These manifold phases—necessary to the successful electrification of the mining industry—were broadly encompassed by the accumulated resources and engineering initiative of the General Electric Company.

Such service and facilities are at the disposal of all industry.

**General Electric**  
Company

General Office  
Schenectady, N.Y.

Sales Offices in  
all large cities

43-349



# After 10 Days

See what this new way does for teeth

All statements approved by authorities

There is a new way of teeth cleaning which millions now employ. Leading dentists everywhere advise it.

You can see the results wherever you look—teeth that glisten as they never did before.

This is to offer a ten-day test. Then to urge that you let your mirror show how much it means to you and yours.

## Fights the film

The object is to fight the film which causes most tooth troubles.

That viscous film you feel on teeth is their great enemy. It clings to teeth, enters crevices and stays. Then it dims the teeth, and night and day it may do ceaseless damage.

It is the film-coat that discolors, not the teeth. Film is the basis of tartar. It holds food substance which ferments and forms acid. It holds the acid in contact with the teeth to cause decay.

Millions of germs breed in it. They, with tartar, are the chief cause of pyorrhea. Very few people escape these troubles which are caused by film.

## What ruins teeth

Much of this film remains on teeth under ordinary brushing methods. Many tooth pastes even favor the film. Thus millions find that well-brushed teeth discolored and decay.

The reason lies in film, and dental science has for years been seeking a way to combat it.

**Pepsodent**  
REG. U.S.  
The new-day dentifrice

A scientific film combatant, now advised by leading dentists everywhere and supplied by all druggists

## 10-Day Tube Free

THE PEPSODENT COMPANY,  
Dept. 802, 1104 S. Wabash Ave., Chicago, Ill.  
Mail 10-Day Tube of Pepsodent to

Only one tube to a family

## Watch the film go

Send this coupon for a 10-day tube. Note how clean the teeth feel after using. Mark the absence of the viscous film. See how the teeth whiten as the film coat disappears. It will be a revelation.

## New Concepts of the Past Century

(Continued from page 276)

the results; and that whether or not his postulate ever be realized, the propositions that he deduces from it, being true, are of scientific interest. Actually, however, it is not quite as simple as all that. If it were sufficient to make a single postulate it would be as simple as all that; but it turns out that this is not sufficient any more than it is sufficient to have a single undefined term. We must have several postulates; and they must be such, as a whole, that a geometry flows out of them. The requirements are three.

In the first place, the system of postulates must be "categorical" or complete—there must be enough of them, and they must cover enough ground, for the support of a complete system of geometry. In practice the test for this is direct. If we get to a point in the building up of a geometry where we could not prove whether a certain thing was one way always, or always the other way, or sometimes one way and sometimes the other, we should conclude that we needed an additional postulate covering this ground directly or indirectly. And we should make that postulate—because it is precisely the things that we can't prove which, in practical work, we agree to assume.

In the second place, the system of postulates must be consistent—no one or more of them may lead, individually or collectively, to consequences that contradict the results of any other or others. If in the course of building up a geometry we find we have proved two propositions that deny one another, we search out the implied contradiction in our postulates and remedy it.

Finally, the postulates ought to be independent. It should not be possible to prove any one of them as a consequence of the others. If this property fails, the geometry does not fail with it; but it is seriously disfigured by the superfluity of assumptions, and one of them should be eliminated. If we are to assume anything unnecessarily, we may as well assume the whole geometry and be done with it.

The geometer's business then is to draw up a set of postulates. This he may do on any basis whatever. They may be suggested to him by the behavior of points, lines and planes, or by some other concrete phenomena; they may with equal propriety be the product of an inventive imagination. On proceeding to deduce their consequences, he will discover and remedy any lack of categoricity or consistency or independence which his original system of postulates may have lacked. In the end he will have so large a body of propositions without contradiction or failure that he will conclude the propriety of his postulates to have been established, and the geometry based on them to be a valid one.

## And What Is It All About?

Is this geometry ever realized? Strictly it is not the geometer's business to ask or answer this question. But research develops two viewpoints. There is always the man who indulges in the pursuit of facts for their sake alone, and equally the man who wants to see his new facts lead to something else. One great mathematician is quoted as enunciating a new theory of surpassing mathematical beauty with the climactic remark "And, thank God, no one will ever be able to find any use for it!" An equally distinguished contemporary, on being interrogated concerning possible applications for one of his most abstruse theorems, replied that he knew no present use for it; but that long experience had made him confident that the mathematician would never develop any tool, however remote from immediate utility, for which the delvers in other fields would not presently find some use.

If we wish, however, we may inquire  
(Continued on page 288)

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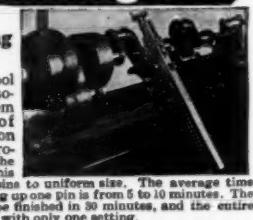
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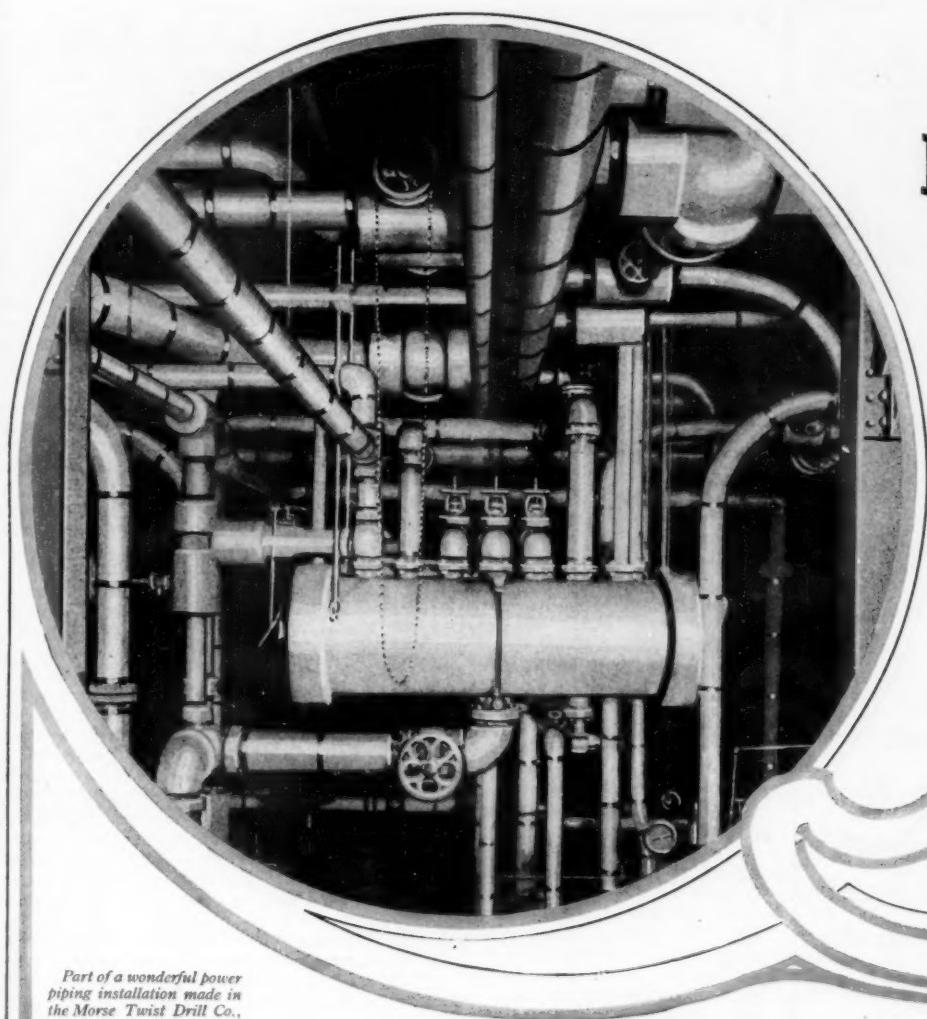


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## Understanding

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## New Concepts of the Past Century

(Continued from page 286)

with perfect propriety, from the side lines, whether a given geometry is ever realized. We may learn that so far as has yet been discovered there are no elements for which all its postulates are verified, and that there is therefore no realization known. On the other hand, we may more likely find that many different sets of elements are such that the postulates can be interpreted as applying to them, and that we therefore have numerous realizations of the geometry. As a human being the geometer may be interested in all this, but as a geometer it really makes little difference to him.

When we look at space about us, we see it, for some reason grounded in the psychological history of the human race, as made up in the small of points, which go to make up lines, which in turn constitute planes. Or we can start at the other end and break space down first into planes, then into lines, finally into points. Our perceptions and conceptions of these points, lines and planes are very definite indeed; it seems indeed, as the Greeks thought, that certain things about them are self-evident. If we wish to take these self-evident properties of point, line and plane, and combine with them enough additional hair-splitting specifications to assure the modern geometer that we have really a categorical system of assumptions, we shall have the basis of a perfectly good system of geometry. This will be what we unavoidably think of as the absolute truth with regard to the space about us; but you mustn't say so in the presence of the geometer. It will also be what we call the Euclidean geometry. It has been satisfactory in the last degree, because not only space, but pretty much every other system of two or three elements bearing any relations to one another can be made, by employing as a means of interpretation the Descartean scheme of plotting, to fit into the framework of Euclidean geometry. But it is not the only thing in the world of conceptual possibilities, and it begins to appear that it may not even be the only thing in the world of cold hard fact that surrounds us. I had hoped to make clear in this place the reason for these statements and something of their significance; but after repeated boiling down I find that these introductory remarks occupy all the space that can be given to the subject in a single issue, so must postpone the conclusion of the matter till another date. This preliminary discussion will have fulfilled its mission if it has made the layman understand why Bertrand Russell, eminent mathematician, was able to say: "Mathematics is the science in which you never know what you are talking about, or whether what you say is true."

## Running the Gauntlet of Quality Production

(Continued from page 278)

sandth of an inch, the tolerance on the hardness is five points on the scleroscope, which is the closest test commercially practicable. Altogether, there are, on this single part, a total of 34 inspection operations, and since many of them must be repeated on each cam, the total number of inspection points is 140. On all the parts named there is one-hundred percent inspection; that is, every one is inspected. On parts where such great accuracy is not required, the inspections are made on five or ten per cent of the parts, and unless trouble is discovered the balance are passed. Because of this fact, it is impossible to say exactly how many inspections of parts have been made for each car assembled. The number will be above 20,000 and below 25,000.

But if inspection of finished parts is necessary, we must not forget that the foundation of the quality of any product must be the materials that enter into it, and in its methods of selecting materials and handling them the American quantity

production system has won a long advantage over the European hand-work system. These methods have now reached a point where nothing is left to chance, and where the exact properties of every piece of metal and of any other material are accurately calculated for the duty it is to do.

The automobile factory of this article purchases 18 fundamentally different kinds of steels, under 45 different sets of specifications, in order to meet the wide range of the needs of a single car. It uses, for the same purpose, seven different brasses, six different bronzes, and so on down the list, each material being chosen to fit a very definite function. Among the non-metallic goods it purchases leather, rubber, wood, glass, felt, fabric, asbestos, cork, gasket materials, bakelite and fibers. The inspection of these materials on their arrival at the plant is only the first step in the process of control.

Many of the materials undergo processes which produce fundamental changes during manufacture. The specifications for the steel alloys, for example, are so varied under heat treatment and carbonizing that it is possible for the factory experts to tell from a single particle of the finished material from which one of more than a hundred working parts it was broken. Finally the Materials Test Division has the added duty of determining from any returned or broken part whether there is any weakness due to manufacture, and recommending changes in specifications to meet it.

For these varied purposes the factory maintains an organization which centers in the laboratories with their expert scientists and elaborate testing machinery, and extends through a system of patrols to every corner of the factory. All materials are watched during processing and not allowed to wait for final inspection to reveal errors. They are constantly held to rigid specifications on all points that at all affect the duties they are to perform.

The testing begins before the purchase of any material, when samples are taken to the laboratories. In these the apparatus is elaborate, covering physical, chemical and microscopic examination. The chemical methods used are checked daily with samples of known content from the United States Bureau of Standards. The physical laboratory includes machinery for testing hardness, tensile machines capable of exerting 200,000 pounds force, torque machines which can exert above 600,000 inch-pounds, and impact machines. The microscopic laboratory is equipped to photograph enlargements of from 30 to 2,000 diameters.

Specifications for purchase of materials are drawn up after the tests on samples have been completed. After delivery of material no lot is permitted to go into manufacture till samples from it have also been tested. This is true whether the purchase is of raw, partly finished, or finished goods, and in the two last named classes of material the specifications have many times been so exacting, and so exactly enforced, that they have resulted in considerable improvements in the factories from which the purchases are made.

To illustrate, the control over a single piece—the ring gear—may be cited. When the steel arrives at the factory it is analyzed chemically for five different elements, which must be in exact proportions. Samples are then heat-treated and tested in the physical laboratories for tensile strength and elasticity. If these are correct, the steel is released, and goes to the forge shop.

There an inspector watches the temperature at which the forging is done. The forged blanks then go for a preliminary heat treatment, where the laboratory inspector checks the pyrometer. There are two heat treatments, then a test for hardness. After being machined the

(Continued on page 290)

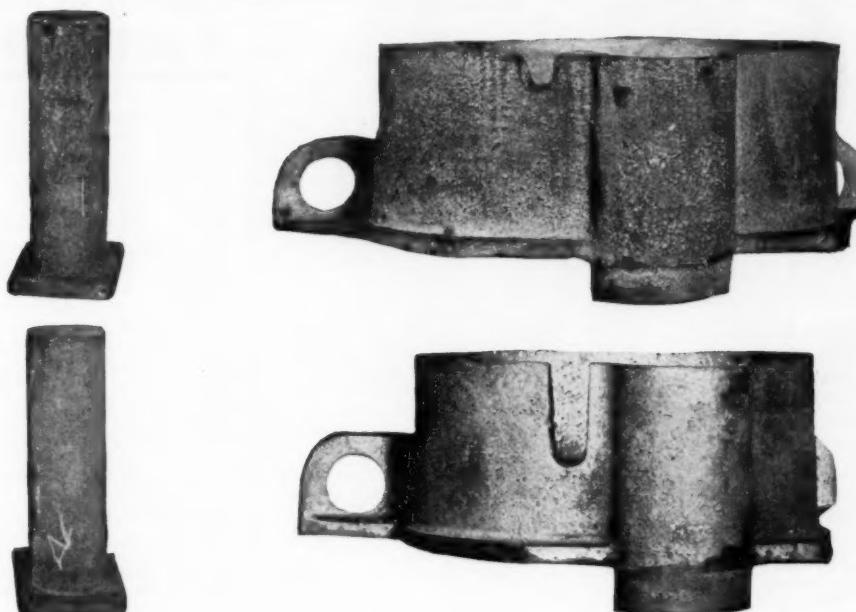


Fig. 1—(Above) castings produced from hand-made moulds in comparison with (below) the same castings as produced by machine moulding.

## Increasing the Use of Jigs Speeds Standardized Production

THE man who coined the phrase "doing it in jig-time" was a musician—not a machinist.

On the other hand, the machinist has put the idea to work at far greater profit than has his musical contemporary.

In point of fact the jig comes close to being the foundation of standardized large-scale production. Therefore, any precaution which either increases the applicability of jigs or reduces time in fitting castings to jigs is multiplied in later operations until it mounts into a saving of first importance. Scores of jobs which, in the practice now adopted in machine-shops, go to the layout tables could just as safely and far more profitably be jigged.

Just one condition determines whether the jig-work can be widely utilized in a machine-shop or whether the slower, more expensive layout process must be generally employed. It is a condition which is decided once for all before the machine shop becomes responsible for the progress of the work. It lies solely in the quality and uniformity of the casting. Neither adaptable machines nor skillful machinists can remedy the loss of time occasioned by poor castings.

Past foundry practice was built around a faulty understanding of human capacity which still persists in many foundries. The moulder is asked to perform operations demanding two utterly opposed abilities.

First comes the heavy work of shovelling sand and ramming it vigorously into the mould.

Immediately he is called upon to stop this heavy muscular labor and try to perform an operation as dainty as any required of a pianist or artist—he is compelled to attempt to draw the pattern accurately and steadily from the mould without causing the slightest flaw in the delicate sand surface, and without disturbing and breaking the thin walls and partitions of the sand by the slightest quiver of his muscles.

Obviously this method demands too much of any human muscles. The result is that after drawing a mould by hand there is immediate need for painstaking "slicking" and "patching" to repair defects in the mould-surface and delicate partitions. This, however, is merely an attempt but not a real remedy.

In the first place these repairs cannot be accurate because of the obvious inaccuracy

of "free-hand" efforts. Secondly the slicked and patched spots in the sand are hardened more densely than other parts of the mould. The gases generated in pouring, instead of escaping freely and evenly at all points, are checked at those dense points, forming pockets of gas and treacherous "blow-holes" in the cast metal.

As a result, when the casting is machined three conditions show up: (1) the pad of finish metal is uneven, demanding extra cuts in many places and thus slowing down production; (2) the uneven texture of the metal is unnecessarily destructive of cutting-tools; (3) blow-holes or lack of alignment compel the scrapping of many castings even after the expenditure of much expensive machine work.

Out of all the centuries in which casting has been carried on it is only in the past fifteen years that the way to solve these obstacles has been found.

The modern cure goes directly to the root of these troubles—it successfully eliminates the uncontrollable variation in every muscular act by substituting machine-power at each step. Moulding machines replace human muscles.

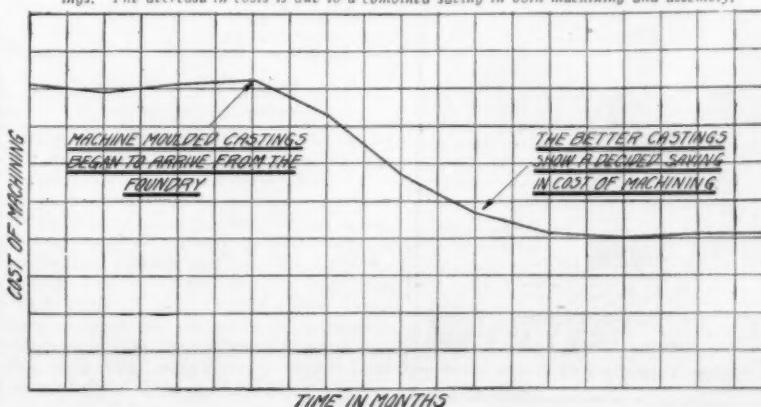
Machine-power rams the sand vigorously but evenly around and over the pattern. It jolts the sand to exactly correct density. It lifts and rolls the flask over smoothly. It draws the pattern without a quiver in true and vertical lift. The mould remains perfect with no need for slicking and patching.

This operation a machine repeats hour after hour through the day without variation. The moulds produced by machine during the fag-end of the shift do not deteriorate nor vary. The castings which come to the machine-shop from a careful machine-foundry are accurate to within  $\frac{1}{16}$ ". This uniformity in size allows the casting to be jigged quickly—a very important and profitable feature. A small casting can be dropped into its jig and it will fit without any adjustment of the jig. A large casting will allow a jig to be placed on it—and again no adjustment of the jig is necessary. The expensive jig thus spends its entire time in useful machining rather than in wasteful adjustments. The uniformly-sized casting not only permits rapid jiggling but also rapid machine work—both in the number of cuts to be taken on each surface and in the uniformity of cut. The temper-truing and costly discovery of a distorted casting—after a part of the machine work is done—is also eliminated.

These results are not limited to machining on any particular type of castings but are common to light, intermediate and heavy work.

The saving in machining costs, due solely to the elimination of human muscle in the previous casting operations, averages 17%, a figure reached by combining reports from machine shops operating on widely different types of work. The percentage of defective castings is reduced, on the average, 71%.

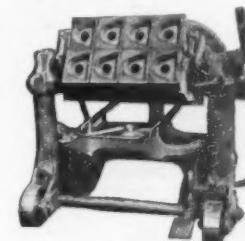
Fig. 2—The graph below shows a typical result of a change from hand-made to machine-moulded castings. The decrease in costs is due to a combined saving in both machining and assembly.



## Better Castings —and More Per Day

The machine-operated foundry not only builds up a list of more solidly-satisfied customers but at the same time profits from internal advantages.

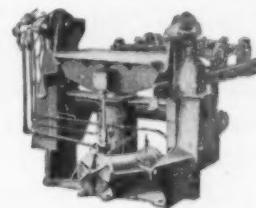
Machine-production of castings increases output without increasing man-power, maintaining steady de-



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PARK TAILORING COMPANY  
Dept 380 Chicago, Ill.

## Running the Gauntlet of Quality Production

(Continued from page 288)

blank is returned for three more heat treatments, the pyrometers and process on each being carefully checked. Then there is a final test to make certain that the results are as they should be. So much for a single part. The process varies, of course, with each part. Similar watch is kept on all, as well as on the handling and mixing of brasses, bronzes, and so forth.

The function of the laboratories does not end with the completion of the car. No product is perfect when first put out, and the laboratories watch for "bugs." Whenever any part comes back as imperfect the laboratories gather it in. The microscope is the usual detective here, and it is possible to tell from the structure of the steel almost exactly what has happened to it.

Recently, for example, a front axle was returned with the complaint that it bent. Tests showed that it was soft, and a piece went to the microscope. This revealed an entirely different structure in the steel from that which was supposed to have left the factory, and indicated that the bar had been heated and hammered. With this clue it did not take long to learn that the owner of the car had been in an accident that bent his axle, had then had it straightened at a garage, and was now trying to get a new one on the false ground of imperfection.

But the principal work is of a different nature, and is illustrated on another axle—that for a truck. It was figured by the engineers that an elastic limit of 100,000 pounds for this piece would be ample, but several broke, and the limit was raised to 125,000 pounds, the laboratories specifying a different heat treatment. There was still breakage, and it proved impossible to get a higher strength with the steels available. So the company went into the market with a demand for a new steel and was able to get one that could stand 160,000 pounds. Still there was a little trouble, and under the microscope it was found that the weakness was in the steel itself. This resulted in the arrangement previously cited, under which the laboratories have full control of the heat-treatment. The specifications were changed, and were rigidly enforced, and the trouble disappeared.

A similar series of analysis was made with ball bearings. At first there was no standard, but exhaustive work finally led to the decision that the necessary quality could be secured by a heat-treatment which would produce the rare structure of spheroidal cementite. This has proved satisfactory, and the manufacturers of the ball bearings have improved their whole product to meet the specifications laid down.

In spite of all care imperfections creep in, and the whole series of tests is capped with two final inspections, one of the engine and at the very last one of the completed car itself. This last inspection is made by a department having no responsibility to the production department, and answerable only to the president of the company. It puts the car into operation and checks this on 34 different points, besides a general inspection for appearance.

## From Fish to Food

(Continued from page 280)

erable depth, and often in going from one side to another they would walk on the fish, causing considerable damage to those trod on. So the modern method is to place the fish into shallow boxes which are piled one on another so that the fish are brought into the cannery in perfect condition. Since most of the fishing boats operate within 20 or 25 miles of the cannery, it is merely an hour or two after being caught that they are delivered ready for canning, and they are processed immediately upon receipt at the

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cannery. The capacity of the sardine boats ranges from 4 to 10 tons, and practically all of them are operated by gasoline engines.

A novel method of locating sardine schools was tried out recently in southern California, and so successful did it prove that a definite scheme has been worked out by the fishing companies. The scheme is to use hydroplanes to skim close to the surface of the water and watch for the schools, and when discovered word is instantly sent to the waiting boats, which go to the locality of the fish. So far, the seaplanes used have been those attached to the Naval Air Station at San Diego, and as these machines are equipped with wireless outfitts the aviators can keep in instant touch with their headquarters. When a seaplane sights a school of fish it wires back to the aviation field from where the information is telephoned to the Fish and Game Commission office at San Diego for distribution to the several canneries in the vicinity.

When the sardines are brought to the cannery, they are hoisted out of the fishing boats in large buckets, weighed and placed in large storage tanks until required for the cutting tables. Surrounding long work tables are large numbers of women who remove the heads and entrails of the fish. The bodies are then placed in large washing-vats, where they are thoroughly cleaned before being spread on flaking trays. These trays are either placed in the sun for the fish to dry or they are run through drying ovens. The tails are next removed and the bodies trimmed to the desired size.

The smaller fish are then fried in olive oil, drained, cooled and sent to the packing table. The larger fish are placed in cans which are inverted on trays and placed in steam vats where the fish are cooked and drained at the same time. The requisite amounts of olive oil and salt are then added, the cans sealed and heated in retorts, and later tested, labeled and packed in cases. To meet the different demands of the trade, the sardines are put up in a variety of sauces, including olive oil, cottonseed oil, tomato catsup, mustard and souce.

The broken bodies and the parts trimmed off in fitting the fish to the cans are made into sardine paste, and the waste parts are cooked, the oil pressed out and the residue made into chicken meal and fertilizer.

The waste in the sardine industry affords excellent material for the preparation of a high-grade fish meal. As it comes from the packing table it has been steam cooked and partially dried in the process of preparing the fish for packing, and can be taken after collection from the packing tables directly to a plant equipped for pressing and drying.

In an experimental plant maintained by the government it was found that from 27 to 33 per cent of meal could be obtained from the fish residue, and from raw materials containing from 12 to 17 per cent of oil, over one-half of the oil was removed by pressing. The oil obtained was bright, clear, and of very high quality. The fish meal from excessively fat fish contained 17.51 per cent of oil. After pressing and drying raw material which contained from 8 to 9.5 per cent oil, a dried meal was obtained containing from 9 to 12 per cent of fat. The meal obtained from this government experimental plant was sent to various points where it was used in feeding experiments with dairy cattle, poultry and pigs. The preliminary experiments conducted with dairy cows were sufficiently satisfactory to warrant a more extended study of the value of fish meal as a dairy feed, and this is now being conducted by the Dairy Division of the Department of Agriculture. The experiments with hens and pigs were likewise satisfactory, and there will probably be a sufficient market to utilize all of the by-products from the sardine industry.



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### Using the Hand Hack Saw

Because a hack saw is so simple a tool, it is one of the most abused. Most of the waste in breakage, and most of the blame for inefficient cutting is due to the inexperience of the user rather than to lack of quality in the blade. Even a little instruction is thoroughly worth while in the interests of hack saw economy.

To quote from *Hack Saws and Their Use*, just published by The L. S. Starrett Company:

"In hand work, see first of all that the blade is well strained in the frame, with the rake of the teeth such that it will cut on the forward stroke. A flexible-back blade, because it lacks natural rigidity, should be strained tighter than an 'all-hard' saw. A properly strained blade, when 'thumbed,' gives a clear, humming note, which, once heard, is easily remembered. In using a flexible blade, the tension should be increased when cutting as the blade stretches while in use."

"If possible, lock the work securely in a vise. In cutting sheet metal, if the gage and size will permit, place the work in a vise so that a flat surface, rather than an edge, is in contact

with the saw. If this is impracticable, put a light strip of wood on either side of the sheet of metal and cut through both the wood and metal at the same time.

"Always place the work in the vise so as to provide as great a bearing for the saw as possible. That is, set the work, if a piece of structural steel, channel or similar material, so as to engage the maximum number of teeth throughout the cut. When placing work in a vise, the tendency of coarse teeth to 'straddle' must be borne in mind, and also that the fewer the teeth engaged at any particular moment during the cut, the greater the strain on each tooth, and consequently the greater likelihood of stripping the blade.

"Start the cut slowly, using the same motion as in filing. Put on enough pressure to make the blade cut, and not slip or slide over the metal. Too little pressure in the first stages of a cut will take more out of a saw than fifty cuts made under proper conditions. By starting with a very light pressure, and allowing the saw to rub rather than cut the work, and then increasing the weight at a destructive rate once the first sharp edge is worn off the blade, it is possi-

ble to so completely ruin a saw that it will not make one full cut on a two-inch round. On the other hand, care must be taken not to use so much pressure that the teeth will engage the work too rapidly, or stripping of the blade may result. At the end of the forward cut, lift the blade slightly to avoid dragging or rubbing the teeth on the stock during the return stroke. Pressure during the return stroke is a frequent cause of premature loss of efficiency in hand hack saw blades.

"Generally speaking, hand hack saw blades should not travel faster than fifty strokes per minute; thirty-five or forty strokes are even better. Care must be exercised to avoid overheating the blade by too rapid cutting, and so drawing its temper. In hand sawing, it will generally be found worth while, after the first few strokes, to retighten the blade in the frame. This takes up any stretch that may have occurred, prevents drifting and tends to produce better cutting. When using flexible or 'soft-back' blades it is absolutely essential that the saw be retightened during use."—From *Hack Saws and Their Use*, published by The L. S. Starrett Company, Athol, Mass., for free distribution.



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This is a book the wireless experimenter cannot afford to be without. It enables one to design and construct their own apparatus. This book will also prove of value to the layman.

SCIENTIFIC AMERICAN PUBLISHING CO.  
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Another method for utilizing the by-products of the fish-canning industry is in the manufacture of commercial fertilizers. Fish scrap is rich in both nitrogen and bone phosphate, and as a fertilizer it is worth at least \$40 per ton.

In the salmon cannery industry it has been found that an average of 30 per cent of the fish that come to the factory is discarded as unsuitable for canning. This includes heads, tails, fins, roe and viscera. This raw cannery waste contains approximately 3.67 per cent of ammonia; 3.46 per cent of bone phosphate and about 10.43 per cent of fish oil. The waste products from the salmon industry alone would yield annually about 11,400 tons of fish scrap and about 2,500,000 gallons of oil. In addition to the salmon caught, large quantities of other fish are brought in and usually thrown away, which could be utilized for fertilizer.

Keeping pace with the expansion of the sardine cannery factories in California are the commercial reduction works which utilize the waste fish. At San Pedro there are several such reduction plants, with a combined capacity of about 1,200 tons of fish per day. In three months these reduction plants handled a total of 15,718,000 pounds of fish, ranging from sharks to sardines, but on some days the run of fish was so great that the plants could not handle them, and in a single day the health department required the dumping out to sea of 185 tons of sardines that could not be handled.

## The Romance of Invention—XVII

(Continued from page 282)

which another worked, or duplicate his own work with mathematical exactness.

The use of tungsten as the target or anode has greatly increased the capacity of the tube for both life and work, on account of its resistance to heat. Under the bombardment of electrons from the hot cathode the target gets greatly heated—indeed, it is perfectly possible to melt even a solid tungsten target if no artificial cooling is resorted to, because more than ninety-nine per cent of the energy input in an X-ray tube is changed in the target into heat. Dr. Coolidge has devised several different systems of cooling, using water, a radiator and a fan, a radiator which is air-cooled direct, and an oil-immersed tube which obtains better cooling as a by-product of its construction, the real reason for immersing the tube in oil being to eliminate the danger of electric shock to operator and patient.

Dr. Coolidge is constantly experimenting on X-ray tubes and accessories. One of the latest developments is the air-cooled, radiator-type tube. To understand the real importance of this improvement it is necessary to remember that while a solid tungsten target tube is capable of rectifying its own current, it does so only with such amounts of energy input as do not heat the target to a temperature approximating that of the cathode. When such a degree of heat is reached the target begins emitting electrons, and if the energy supplied is an alternating potential, an "inverse" current passes. This "inverse" cathode-ray stream hits the glass just behind the cathode, heats and usually cracks it, and of course ruins the tube. The trouble is cured, as far as danger is concerned, by having a cathode-focussing device of either tungsten or molybdenum, which is so designed as to intercept the "inverse" stream; but while efficient as a safety device this does not permit an increase in capacity of the tube. What is wanted is more power in one stream of X-rays, not two streams from two different points.

To increase the capacity of a self-rectifying tube it is necessary to take away heat, so that no "inverse" current shall be formed. Moreover, without some cooling system, the waits between operation for cooling of the heated target are

long. With the fin-type radiator of copper connected to a copper anode-arm with a tungsten target (copper being a much better conductor of heat than tungsten) the tube can be used much longer than with the usual uncooled tungsten anode, without undue heating; and it cools with relative rapidity between uses, because of the good conduction and radiation of heat by the copper anode and fin radiator. Inasmuch as in the new tube, the greater part of the heat energy is radiated through the radiator and not through the glass, the glass tube may be much reduced in size (3½ inches is now a standard).

Another contribution to the physician which has recently come from Schenectady is the portable X-ray outfit, which attaches to any lamp socket and may be carried in a physician's automobile. The advantages of carrying the apparatus to the patient rather than the patient to the apparatus are obvious. Indeed there are many cases where lives might be saved could X-ray pictures be made, which must be lost because of the impossibility of moving the patient. Time and expense are always to be saved by the use of a portable X-ray outfit, not to mention suffering, as in the case of broken bones, which should be photographed. This however entails difficulty and pain if the patient must be ambulated and pain if the patient back again.

The portable outfit includes a stand to hold the tube, a transformer and a control apparatus, which is so simple as to be fool-proof and which also makes automatic exposures possible. The tubes to be used with this outfit are of a new, small type made of very thick glass which is fifty-five per cent lead, giving the same protection to operator and patient as a one-sixteenth-inch sheet of pure lead. The X-rays can escape from the tube only through a small window of lime glass.

Dr. Coolidge's work must be considered in the light of the great resources supplied him by the electric company and the facilities and assistants provided. Dr. Coolidge desires that full credit be given to the many assistants who have helped in the development of ductile tungsten, the hot cathode tube and the other improvements made in X-ray outfits. For instance, were it not for the Langmuir mercury-vapor vacuum-pump no such high vacuum as is now produced in X-ray tubes would be possible. Without the conveniences and the disregard of necessary expense for lengthy and tedious investigations, no such developments as have taken place in either the arts of making over the most refractory metal in existence into a tractable substance, or of producing X-ray tubes which are instruments of precision rather than hit-or-miss X-ray producers, would have occurred.

In the development of Roentgenology lie the greatest possibilities both for the cure of certain difficult ailments to which the human machine is subject and the diagnosis of others which, without some such investigative methods, can be treated only by hope and guess work. It is well realized that the science is only in its infancy, and that, with increased penetration, that even approaches the most penetrating radiations of radium in character, much that is new is yet to be discovered and much that is helpful is to be developed. The man whose efforts have accomplished so much in this department of research is young, enthusiastic, vitally interested in his work, and with plans made ahead which already promise even more interesting developments and discoveries than those which he has already to his credit. He is to be congratulated upon having found a place in the organization for which he labors, but the general public is even more to be felicitated that the great research laboratory at Schenectady should have made its own so original and enthusiastic a scientist as the subject of this sketch.



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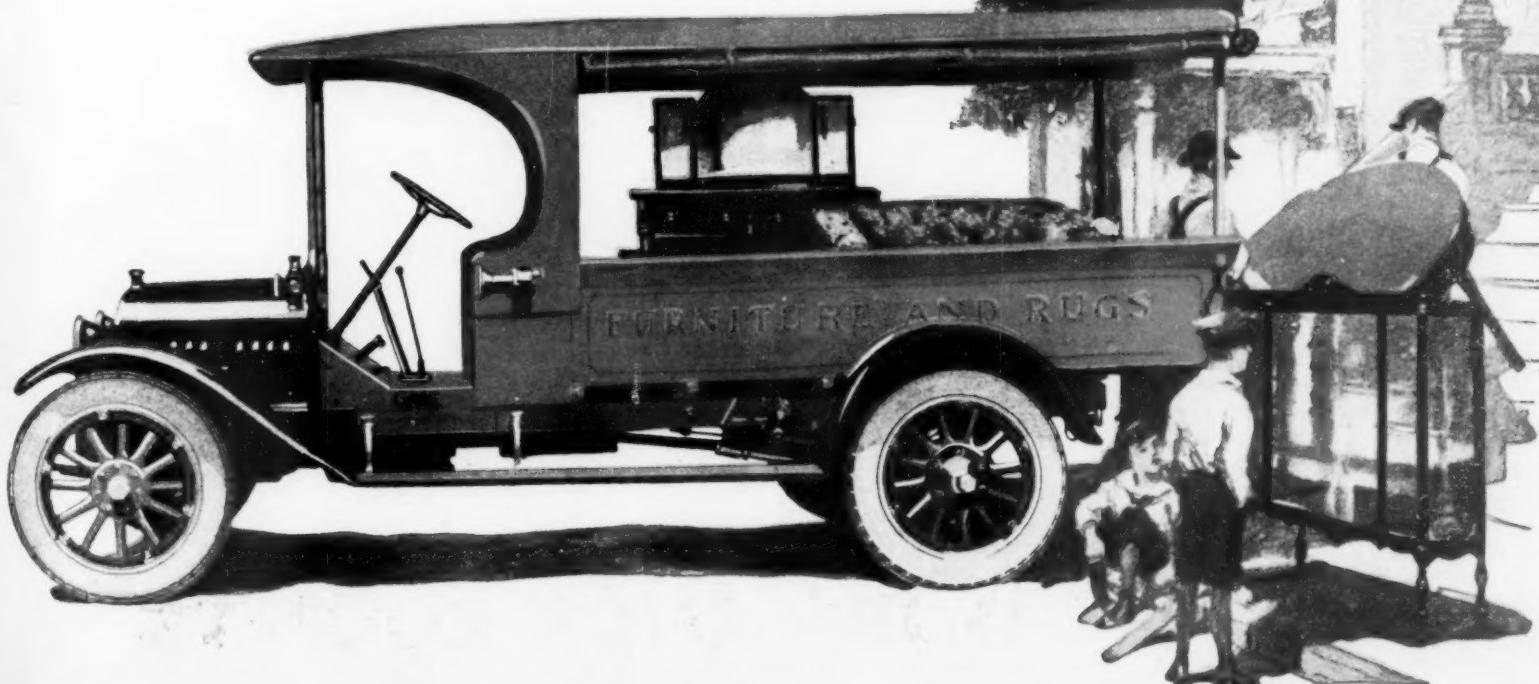
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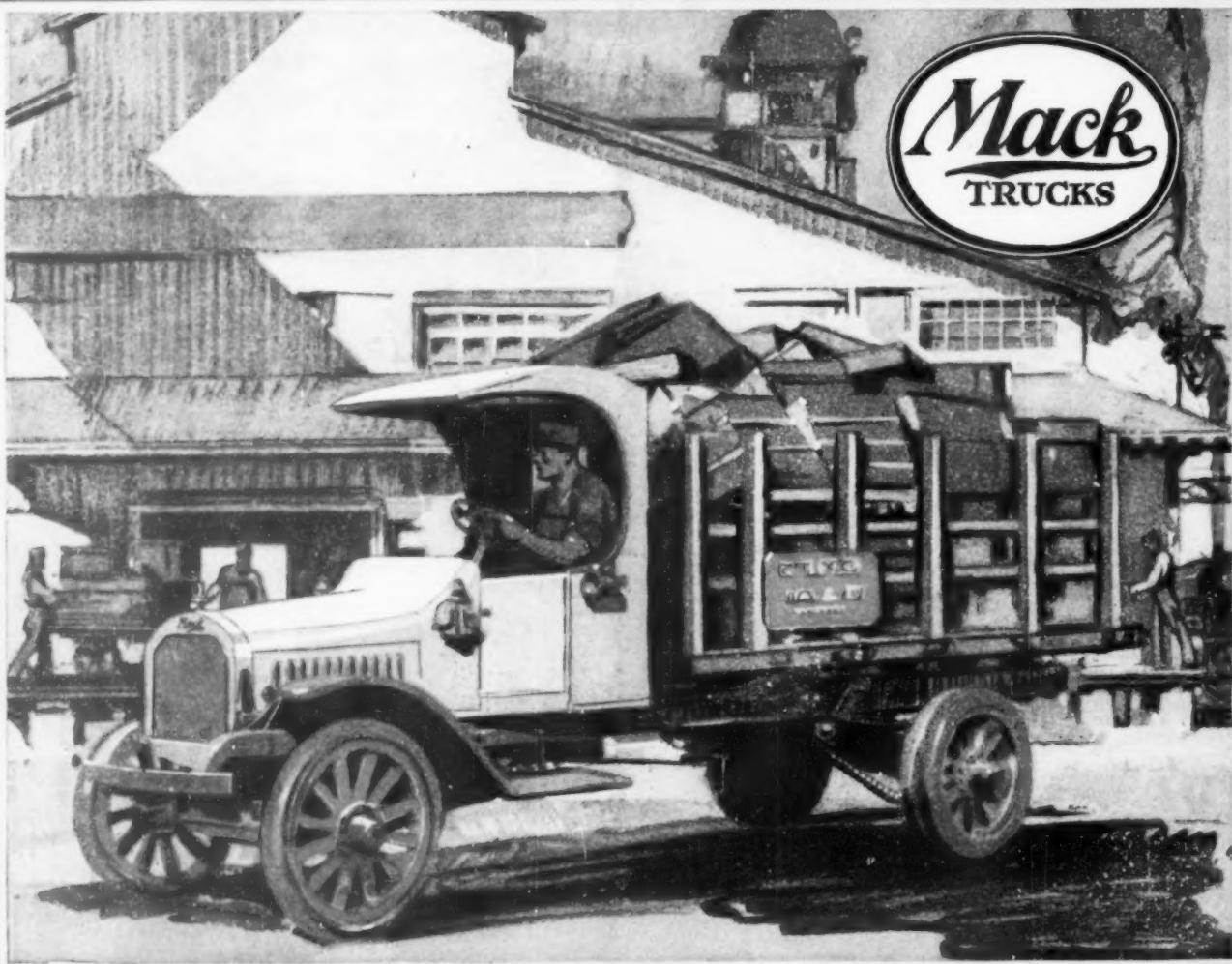
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